Evaluation Design Report:
Roads Rehabilitation Project Evaluation

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Mozambique Roads Rehabilitation Project Evaluation

Evaluation Design Report

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DISCLAIMER

The views and opinions expressed herein are those of the authors and do not necessarily represent those of MCC or any other U.S. Government entity.

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LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
ACP	Asphalt Pavement
ADT	Average Daily Traffic
ANE	*Administração Nacional de Estradas* (National Roads Administration)
TM	American Standard Test Method
BAU	Business As Usual
CA	Constraints Analysis
CBA	Cost-Benefit Analysis
CBR	California Bearing Ratio
CIS	Commonwealth of Independent States
CP	Conditions Precedent
DO	Development Order
DPWH	Department of Public Works and Highway
EAR	Evaluability Assessment Report
EBRD	European Bank for Reconstruction and Development
EDR	Evaluation Design Report
EIF	Entry into Force
EIRR	Economic Internal Rate of Return
EMC	Evaluation Management Committee
EMP	Evaluation Management Process
EQ	Evaluation Question
ERR	Economic Rate of Return
ESALF	Equivalent Standard Axle Load Factor
ESIA	Environmental and Social Impact Assessment
FDDR	Final Due Diligence Report
GDP	Gross Domestic Product
GOM	Government of Mozambique
HDM-4	Highway Development and Management-4
IDG	International Development Group LLC
IM	Investment Memo
IRB	Institutional Review Board
IRI	International Roughness Index
KII	Key Informant Interview
MCA-M	Millennium Challenge Account Mozambique
MCC	Millennium Challenge Corporation
MTC	Manual Traffic Count
N1	*Estrada Nacional*/National Route 1
NPV	Net Present Value
O-D	Origin-Destination
ODC	Other Direct Costs
ORN	Transport Research Laboratory Overseas Road Note
PARPA	Action Plan for the Reduction of Absolute Poverty
PTU	Public Transport User
QA/QC	Quality Assurance/Quality Control

RED	Roads Economic Decision
RMC	Road Maintenance Company
RRP	Roads Rehabilitation Project
SDA	Sustainable Development Account
SN	Structural Number
SUV	Sport Utility Vehicle
VOC	Vehicle Operating Cost
WB	World Bank

I. INTRODUCTION & BACKGROUND

I.1 COUNTRY CONTEXT

The Millennium Challenge Corporation (MCC) and the Government of Mozambique (GOM) signed a five-year, US$506.9 million Compact on July 13, 2007, which ended on January 20, 2014.[1] The Compact goal was to reduce poverty through economic growth in the four Northern provinces of Mozambique: Niassa, Cabo Delgado, Nampula, and Zambezia. The Compact had four primary objectives, which were implemented via a distinct project for each objective: 1) Increase access to reliable sources of potable water supply and improved sanitation facilities, 2) Increase access to productive resources and markets while reducing transport costs, 3) Establish efficient and secure land access for households, communities, and investors, and 4) Protect and restore healthy coconut supply, and diversify farmers' income. The Roads Rehabilitation Project pertains to Objective 2 and had a budget of $176.3 million.

I.2 OBJECTIVE OF THE REPORT

On September 25, 2020, MCC issued a contract to International Development Group LLC (IDG) to conduct an Economic Analysis and Independent Evaluation Services in support of the Mozambique Roads Rehabilitation Project (RRP). The evaluation, designed to understand the impact of the RRP on Mozambique's economic growth, is mainly threefold: 1) a review of the activity implementation (Evaluation Area 0) to identify any deviations from the original design, 2) a performance evaluation (Evaluation Area 1) around reductions in transportation costs on the MCC-funded roads, and 3) performance evaluations of road maintenance, road usage patterns, and transport market structure (Evaluation Areas 2, 3, and 4).

The objective of the Evaluation Design Report (EDR) is to allow MCC to accomplish the following:[2]

- Prioritize evaluation questions and outcomes that meet demand from key decision-makers;
- Ensure that the Program Objective and all key accountability metrics modeled in the cost-benefit analysis are measured or justification is provided as to why they are not;
- Apply the most rigorous evaluation methodology feasible given project design and implementation rules;
- Clearly define the analysis plan to ensure consensus on outcomes – their definitions and measurement;
- Clearly define sample population and sampling strategy that aligns with project target populations;
- Clearly define exposure period that maps data collection timelines with project start date timelines; and
- Ensure alignment between evaluation design and contract funding and initiate a budget modification, if necessary.

[1] "Millennium Challenge Compact Between the United States of America acting through the Millennium Challenge Corporation and the Government of the Republic of Mozambique," July 2007.
[2] MCC Independent Evaluations Management Guidance – External, Version: February 2020.

In this report, the team will: i) provide an overview of the Compact and the RRP, ii) present quantitative and qualitative evaluation design for each evaluation question, and iii) summarize administrative issues of the evaluation.

II. OVERVIEW OF THE COMPACT AND THE INTERVENTIONS EVALUATED

II.1 OVERVIEW OF THE PROJECT AND IMPLEMENTATION PLAN

II.1.1 Original Project Description

The Compact originally called for the Roads Project to rehabilitate 491 kilometers of high priority roads spread across three northern provinces. However, in 2011, as a result of the increase in construction cost, the project was re-scoped to the rehabilitation of two primary *Estrada Nacional*/National Route 1 (N1) road segments:

- Namialo-Rio Lurio Road Activity – 149.7 kms
- Nampula-Rio Ligonha Road Activity – 103 kms

The overarching objective of the Roads Project is four-fold:

1. Improve access to markets, resources, and services;
2. Reduce transport cost for the private sector to facilitate investment and commercial traffic;
3. Expand connectivity with the Northern region and with the Southern half of the country; and
4. Increase public transport access for individuals to take advantage of employment and other economic activities.[3]

In September 2018, IMC Worldwide, Inc. began work on the Mozambique RRP Evaluation and submitted an EDR, which was approved by MCC in 2019. In September 2020 MCC issued a new award for the Mozambique RRP Evaluation to IDG, which included modifications to the evaluation questions made by MCC.[4] IDG's EDR builds on data shared by MCC, which was collected as a part of the IMC evaluation, with changes in the design and methodology based on data independently gathered by IDG and reflecting more recent changes in the operating context, notably the global COVID-19 pandemic. The current EDR also incorporates the modified evaluation questions made by MCC ahead of the procurement of this evaluation.

Mozambique emerged from a decades-long civil war in 1992. Since then, the population of the country has grown to approximately 29 million, with around 70% of the population residing in rural areas and dependent on agriculture as their main livelihood.[5] Although Mozambique has experienced economic growth over the past three decades and had a pre-pandemic growth rate of

[3] MCC Compact, Annex I, pg 9.

[4] IMC's EDR (2019) is available on MCC's website at the following link: https://data.mcc.gov/evaluations/index.php/catalog/246/download/1242.

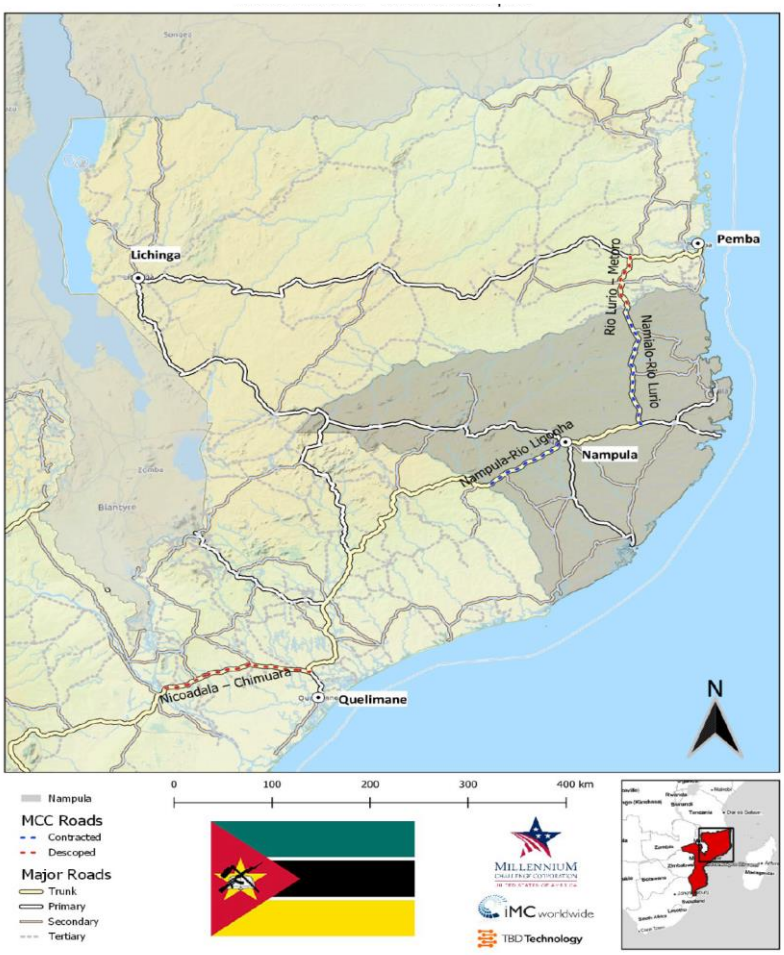
[5] https://www.worldbank.org/en/country/mozambique/overview#:~:text=With%20this%2C%20growth%20is%20expected,shocks%20and%20limited%20fiscal%20space.

over 4%, more than half of the population still lives in poverty. The GOM has highlighted the importance of developing a strong roads infrastructure as part of its poverty reduction plan. In addition to the four over-arching objectives of the Roads Project noted above, the RRP was also expected to enhance the socio-economic lives of the population in the two provinces by enhancing access to health, education, and employment opportunities.[6] Over 50% of the population in the two provinces of Nampula and Cabo Delgado are of working age and were expected to benefit with increased employment after the roads had been developed.[7]

II.1.2 Geographical Coverage

The RRP improved two N1 primary road segments, connecting Nampula to Rio Ligonha, and Namialo to Rio Lurio. The road segments improved with MCC investment are presented in Figure 1 below:

Figure 1 Map of MCC Roads[8]



[6] MCC Compact. Annex 1, pg. 10.

[7] Ibid.

[8] IMC Worldwide, Inc., Evaluation Design Report in support of the Roads Rehabilitation Project in Mozambique, May 2019.

II.1.3 Description of Implementation to Date

II.1.3.1 Roads Rehabilitation Project (RRP)

In line with the four key objectives of the Roads Rehabilitation Project, the Compact had envisaged the rehabilitation of approximately 493 kilometers of roads in Northern Mozambique. Feasibility studies were conducted to ascertain the viability of rehabilitation of the roads. The feasibility studies identified high costs of construction, because of which not all the roads identified in the compact were rehabilitated. The table below captures the original plan of roads rehabilitation across the three Northern provinces of Zambezia, Nampula and Cabo Delgado.

Road Name	Province	Length (Km)
Chimuara-Nicoadala	Zambezia	165.5
Rio Ligonha-Nampula	Nampula	103
Namialo-Rio Lurio	Nampula	150
Rio Lurio-Metoro	Cabo Delgado	74.8
TOTAL		**493.3**

In November 2010 a revised economic analysis was conducted to help ascertain the final investment decision of the roads rehabilitation. Finally, 253 kms of the N1 road was rehabilitated. The Chimura-Nicoadala and Rio Lurio-Metoro roads in the Zambezi and Cabo Delgado provinces, respectively, were not part of the rehabilitation. According to the Indicator Tracking Table from 2013, approximately 253 km of the N1 road was split across three contracts as detailed in the table below:

Table 1 RRP Construction Works by Road Segment, Contractor, & Road Length Completed

Road Segment	Contractor	Road Length (km)
Segment 1: Nampula – Rio Ligonha	SMEC (Supervising Engineer)	103
	CMC/Razel, JV (Contractor)	
Segment 2: Namialo – Ponte Mecutuchi	Scott Wilson (Supervising Engineer)	75
	CMC di Ravennae– (Contractor)	
Segment 3: Ponte Mecutuchi – Rio Lurio	Scott Wilson (Supervising Engineer)	75
	CMC/Razel, JV (Contractor)	
TOTAL		**253**

The rehabilitation activities that took place on the three road segments on the N1 road are the following:

- Lane configuration rehabilitation on Nampula-Rio Ligonha and Namialo-Rio Lurio.
- Design and construction of drainage structures such as catchment basins, manholes, pipe culverts, kerbing, channel collectors and sub-collectors.
- Signage posts installation and safety improvement incorporations.

The rehabilitation of these sections of the N1 road has enhanced access nationally and internationally to agricultural and fisheries' outputs from the Northern provinces in Mozambique. The rehabilitated roads further augment enhanced connectivity and reduced vehicle operating costs.[9]

As per MCC's Indicator Tracking Table, by 2028, nearly 1.2 million beneficiaries in districts adjoining the N1 roads in Nampula are expected to benefit from the rehabilitation. Approximately, 368,500[10] citizens will accrue benefits from the 149.7 km Namialo-Rio Lurio segment and 869,250 citizens will benefit from the 103 km segment of the Nampula-Rio Ligonha segment. As the road improvements lead to higher traffic volumes, making transportation more affordable for agriculture, industry and commerce, resulting in reduced prices of goods and improvements in farm-gate prices. There is expected to be a higher efficiency in the operations of bus services which will benefit citizens by creating easier access to health care, education and employment opportunities.

II.2 THEORY OF CHANGE

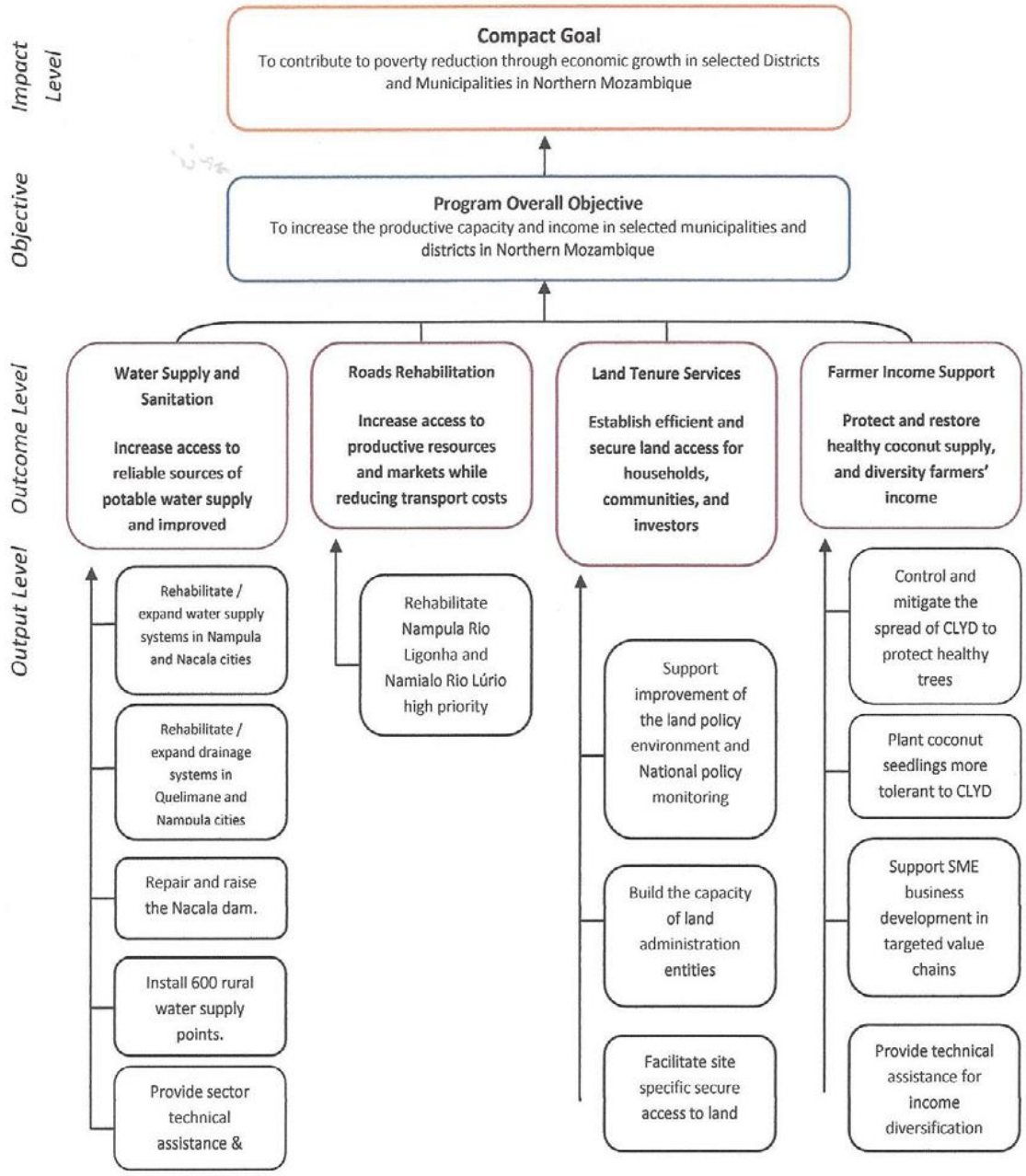
II.2.1 Final M&E Plan Project Logic

The Roads Project logic is based on the premise that the rebuilding of roads and bridges in the region was a priority and a necessity for agriculture development in the country, given that 70.2% of Mozambique's workforce is employed in agriculture,[11] and 3.2 million smallholder farmers account for 95% of Mozambique's agricultural production.[12]

The Compact Program logic diagram (see Compact, Annex III and M&E Plan)[13] for the Roads Project shows the rehabilitation of high priority roads in selected provinces (inputs) leading to an increase in access to productive resources and markets (first order outcomes), in turn increasing the productive capacity in selected districts in Northern Mozambique (second order outcomes), and finally poverty reduction (impact). (See Figure 2)

[9] Mozambique RRP Indicator Tracking Table.
[10] Monitoring and Evaluation Plan, Compact closeout, December 2013
[11] International Labour Organization, ILOSTAT database, via World Bank
[12] FAO. Mozambique at a glance. http://www.fao.org/mozambique/fao-in-mozambique/mozambique-at-a-glance/en/
[13] M&E Plan, pp. 64-71

Figure 2 Final M&E Plan Project Logic



The original program logic diagram does not describe outcomes that will lead to the goal, but a detailed program logic specifically for the Roads Project is presented below.

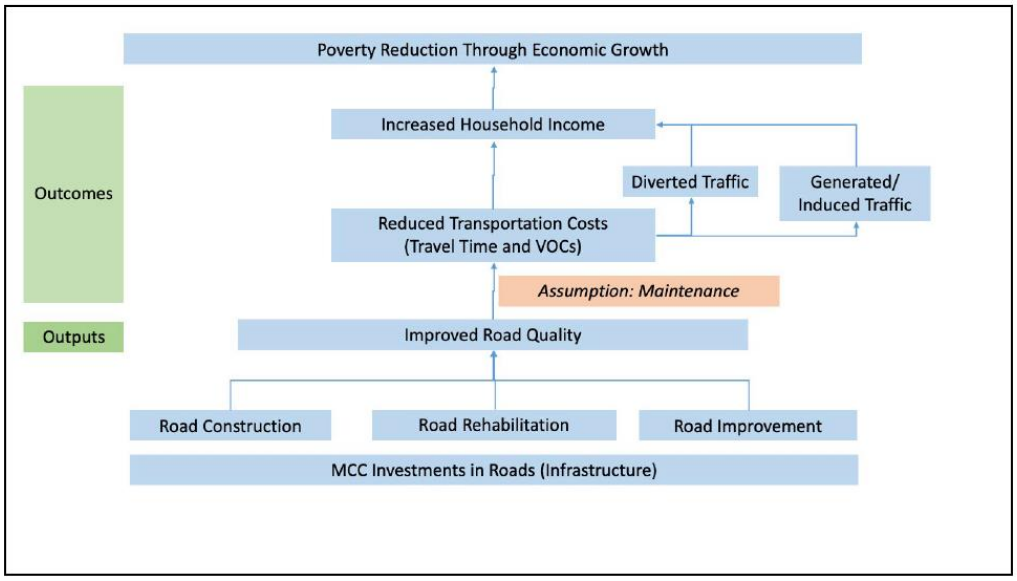
II.2.2 MCC Transportation Project Logic

MCC has developed project logic guidelines specific for transportation projects which more fully reflect key inputs, outcomes, and assumptions. According to MCC's guidelines on project logic

for transportation projects, road project inputs (Figure 3)—comprising road construction, rehabilitation, and improvement—will lead to improved road quality through a series of intermediate outcomes. Assuming good maintenance practices, this will lead to the outcomes of reduced transportation costs, measured in travel and vehicle operating costs (VOCs). These outcomes, in addition to the effects of diverted and generated traffic, will lead to a long-term outcome of increased household income, which is anticipated to result in the project's long-term goal of poverty reduction and economic growth.

Figure 3 MCC Transportation Project Logic

(Source MCC monitoring and evaluation 2018)



II.3 COST-BENEFIT ANALYSIS

II.3.1 Pre-Compact CBA (MCC Original ERR)

The closeout CBA indicates an economic rate of return (ERR) of 10.3% for the originally planned project under the Compact. The original project considered four road sections with a total length of 493km.[14] Subsequent to the completion of feasibility studies and detailed design in 2010, the estimated cost of improvement has substantially increased from 0.35 million USD per km to over 0.5 million USD per km. The increase in cost necessitated re-scoping and subsequently the number of roads to be improved was reduced from four to two, and the length of roads to be improved reduced from 493 km to 253 km. The latest monitoring and evaluation plan dated December 10, 2013 reports revised pre-Compact ERRs as below:[15]

Date	Context	Road Segments	ERR
2009	Original ERRs	Nampula - Rio Ligonha Namialo – Rio Lúrio	7.1% 6.7%

[14] MCC Rehabilitation/Construction of Roads Project ERR spreadsheet dated January 18, 2014.
[15] MCA-Mozambique Monitoring and Evaluation Plan December 10, 2013 (Compact Closeout).

Date	Context	Road Segments	ERR
2012	Re-scoped project due to high investment rehabilitation construction costs per kilometer	Nampula - Rio Ligonha Namialo – Rio Lúrio	0.65% [16] -0.19%

As reported in the M&E plan, the original ERR prior to 2010 was estimated using the World Bank's RED model. The 2010 feasibility study and analysis during re-scoping used the HDM-4 model. As the N1 is a national, paved road, HDM-4 is more appropriate for the economic analysis as the RED model is primarily used for rural roads with low traffic volume as well as unpaved roads. HDM-4 allows for modeling of the impact of maintenance interventions over the analysis period, whereas RED does not model road deterioration and uses an average value of road roughness over the analysis period.

The ERR reported after re-scoping considered different likely maintenance scenarios such as no periodic maintenance, regular periodic maintenance, or periodic maintenance when the IRI reaches 6 m/km. The maintenance assumption used for the ERR given in the M&E plan is not reported. The cash flow statement used for any of the ERR's reported above are not available. The HDM-4 files for the project shared include several analysis options used. The input files themselves are accessible and can be entered into the HDM-4 software, but the evaluation team found that when the model is run, attempting to view the output produces an error in the software. The naming of the HDM-4 file folders includes the year as 2011 and the HDM-4 files for the two roads shared are assumed to be created/updated during rescoping and project closeout. All data and analysis assumptions used in the HDM model are available.

II.3.2 Post-Compact CBA (MCC Close-out ERR)

The close-out ERR is reported as 4.77% for the Namialo-Rio Lurio road and 11.85% for the Nampula–Rio Ligonha road.[17] As stated above, the evaluation team encountered difficulty in running the available HDM-4 model and extracting outputs. The HDM-4 input and analysis option in the model will be used to the extent applicable in the evaluation. The ERRs are calculated as a weighted average of the two maintenance assumptions (with a 70% weightage for the high maintenance scenario and 30% weightage for the low maintenance scenario) as observed in the cash flow statement showing the ERR calculation at closeout. The ERR for the two road projects combined is 7.3%.

II.4 PROJECT PARTICIPANTS AND BENEFICIARY ANALYSIS

At Compact signing, the number of potential beneficiaries in districts adjoining the roads, with improved access was estimated to be 2.3 million by 2015. More than 60% of the beneficiaries were expected to be in Nampula.[18] However, it is better practice, as later expressed in MCC's *Principles into Practice*, to define road project beneficiaries as road users and not those living near the improved road segment.[19] This approach is reflected in the Compact Closeout estimate of 1.2

[16] M&E Plan, Annex V– MOZ-V4 - Sep14 includes edited ERRs of 2.45% (Namialo-Rio Lurio Road) and 1.06% (Nampula – Rio Lighonha Road).
[17] MCC Rehabilitation/Construction of Roads Project ERR spreadsheet dated January 18, 2014.
[18] MCC Mozambique Compact, Annex I, p. 10.
[19] Millennium Challenge Corporation, *Principles into Practice, Lessons from MCC's Investments in Roads*, November 2017.

million beneficiaries.[20] The evaluation will consider as project beneficiaries the N1 road users on the Nampula-Rio Ligonha and Namialo-Rio Lurio primary segments. The evaluation is focused on measuring the changes in outcomes for individuals using the road. Therefore, in order to estimate to what extent road users live within the region as opposed to outside the region, a question will be asked as part of the O-D survey about where they reside, beyond just where they are coming from and going to. This information will be used to estimate the extent to which the road benefits are local vs. national (or international).

II.5 LITERATURE REVIEW

II.5.1 Summary of the Existing Evidence

Evaluation Question 0: **Was the project implemented according to plan? [Result: Road Rehabilitation]**

Summary of existing evidence is not applicable for Evaluation Question 0.

Evaluation Question 1: Did the project reduce transportation costs? Was the magnitude of this reduction the same as was expected in the MCC investment decision CBA for the same exposure period? Why or why not? Was the MCC investment to achieve this reduction cost-effective (defined as exceeding MCC's 10% economic rate of return hurdle rate)? Is the current Economic Rate of Return (ERR) for the project different than the investment-decision ERR? If so, why? How could the project have been designed to result in a higher ERR? [Result: Reduced Transportation Costs]

MCC's *Principles into Practice* series on road investment provides some evidence on ex-post calculation of economic return for road investments. It highlights MCC's compact with Honduras, which included the Honduras Transport Project and Farm to Markets Roads Activity. It reports that the ex-post ERR of MCC's road investment in Honduras decreased due to higher final investment cost and lower-than expected traffic counts for a highway improvement. A secondary road improvement, however, experienced higher than expected traffic and lower project costs, which increased the ex-post ERR.[21] A road investment in Nicaragua resulted in lower ex-post ERR than ex-ante ERR possibly due to data collection timing, as the endline data was collected less than one year after road construction.[22]

There have been a number of Roads Rehabilitation Projects in Mozambique such as the Pemba-Montepuez rehabilitation project, approved in 1977, the Beira Corridor Transport System Project, approved in May 1988, and the Transport Programme approved in 1992. The African Development Bank funded Vanduzi-Changara Road Rehabilitation Project was identified by the GOM as having heavy international and inter urban traffic. Apart from the Pemba-Montepuez project, most road transport projects have been well executed in Mozambique.[23]

[20] Monitoring and Evaluation Plan, Compact closeout, December 2013.
[21] Millennium Challenge Corporation, *Principles into Practice, Lessons from MCC's Investments in Roads*, November 2017, p.27.
[22] *Ibid*., p.28.
[23]https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Mozambique_-_Vanduzi-Changara_Road_Project_-_Appraisal_Report.pdf

The 270 km long Vanduzi-Changara road has an ex-post evaluation which has calculated the economic benefits of the road using the HDM model of economic analysis.[24] The traffic volumes used for projections were obtained from the latest traffic data report prepared and issued by ANE. Since 1992, consultants and the ANE undertook classified counts, an O-D survey and KIIs. The 1999 classified counts by ANE establishes the base year traffic by vehicle type for projection purposes; the O-D survey served to indicate characteristics of traffic flow; while the interviews with major economic entities provided information for present and future traffic volumes and its distribution on the project road. In 1996, the average daily traffic (ADT) ranged from 361 (Catandica – Guro) to 567 (Catandica – Vanduzi). For purposes of analysis the road is divided into four links and 2% growth rate was applied. This figure was conservative and lower than the population growth rate in Mozambique and GDP growth in 1997. The traffic volumes for 1999 are: Beira Road Junction-Vanduzi 586 vehicles per day (vpd); Vanduzi-Catandica 602 vpd; Catandica-Guro 383 vpd; and Guro-Changara 349 vpd. The volumes during 2021, which is the final year of the analysis, range from 1,248 vpd; 1,478 vpd; 1,012 vpd and 984 vpd respectively.[25] For each of the proposed design alternatives and maintenance scenarios, the economic costs were established and utilized in the HDM model economic analysis. The economic analysis is based on the comparison of the situation without the road rehabilitation (assuming basic maintenance) compared with the different project rehabilitation scenario. The costs and benefits for each alternative were calculated for the project's 20-year design period and the resulting net benefit discounted to obtain the economic internal rate of return of 29%. IDG has not been able to verify the latest ERR for this project.

Evaluation Questions 2A: What are the relevant road authority's current maintenance practices? What is the likelihood that MCC's investment will remain adequately maintained for the life of the investment? Additionally, what maintenance regime (presented graphically, with time on the x axis and International Roughness Index (IRI) on the y axis) reflects current practices and will therefore be used in HDM-4? What maintenance practices most influenced your selection of this regime? Finally, there was some debate during compact re-scoping as to whether the counterfactual should include periodic maintenance or not. Which counterfactual is most likely, and what evidence do you have to support this choice? [Assumption: Maintenance]

According to a World Bank report from 2005, if roads are not maintained on an annual basis, roads may require reconstruction at approximately three times the cost of maintenance. If a government does not spend on maintenance in a particular year, then the cost of maintenance is higher the following year.[26] This encourages many developing countries to continue deferring maintenance due to mounting costs. Therefore, understanding road maintenance practices is crucial to understand whether maintenance works will be performed.

Robust maintenance programs – either performance-based maintenance contracts, community-based programs, or other methods – ensure road maintenance mechanisms remain intact during the life of the investment. Research has shown that countries that have implemented performance-based maintenance contracts have incurred cost savings between 15%-30%, since these contracts

[24] Ibid.

[25] Ibid.

[26] Sally Burningham and Natalya Stankevich, "Transport Note: Why road maintenance is important and how to get it done," *The World Bank,* June 2005, http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1227561426235/5611053-1231943010251/TRN4_Road_Maintenance.pdf

are fixed price and contractors have an incentive to maintain the contracted service levels at the lowest cost possible. Malaysia is an example of a developing country that implemented such a contract which yielded positive results; in 2000, the Government of Malaysia implemented a 15-year-long performance-based maintenance contract, which enabled the government to secure sufficient road maintenance funds for the investment's duration.[27]

Road maintenance in Mozambique is funded by the Road Fund and conducted by ANE. All 30,000 km of national roads come under ANE's purview and they are responsible for maintenance and rehabilitation of those roads. District and municipal roads are not part of ANE's portfolio. In each province there are multiple firms that conduct road maintenance. ANE selects maintenance firms through a competitive procurement process. They also do a combination of performance based and traditional contracts with firms. At the same time, ANE also breaks down each road section into 2-3 zones and awards maintenance contracts to different firms for each zone. The intention is to de-risk maintenance activities and also ensure a merit based and transparent procurement process. For example, the 103 km of the Nampula-Rio Ligonha is divided into two zones and different maintenance firms work in each zone. [28]

Periodic maintenance is not conducted on all roads because of paucity of funds. However, ANE undertakes repairs and maintenance, through routine maintenance activities, of roads when the need arises, using the Highway Maintenance System (HIMS). ANE's regional teams based in each province, works with independent consultants that supervise road maintenance and ensure that the maintenance firms conduct robust maintenance of the roads. The consultants also help in identifying future maintenance requirements of the roads and also conduct data collection for gathering traffic count numbers on the roads annually, which further helps ANE in allocating funds for maintenance for the roads.

Mozambique has a five-year government plan broken down annually for road maintenance.[29] The Road Fund[30] is responsible for making funds available to ANE for road rehabilitation and maintenance. The Road Fund collects tolls from road users and transit fees on foreign registered vehicles. However, the collections only contribute to approximately one third of the overall funds needed for road maintenance.[31] As per the *Programa Integrado do Sector de Estradas* (Integrated Program of the Road Sector, or PRISE) report for 2019,[32] while there is increased efficiency in road funding resources in Mozambique, the budget execution of roads construction and maintenance are influenced by macroeconomic constraints in the country and shortage of funds to honor invoices of maintenance activities.

Evaluation Question 2B: **The Mozambique Compact included text requiring policy, legal and regulatory reforms related to maintenance, as listed on Annex I - page 13 of the agreement. What were the effects on road maintenance of these requirements? [Assumption: Maintenance]**

[27] CAREC & ADB, "Guide to Performance Based Road Maintenance Contracts", Apr, 2018, p.2
[28] Coanai, Miguel. 2021, Mar 3. Meeting with ANE, Mozambique
[29]http://ufsa.gov.mz/Docs/ANE/P158231%20-%20MZ%20IFRDP%20-%20ESMF%20-%20Final%20-%2023FEB18.pdf
[30] Simoes, Irene. 2021, Mar 11. Meeting with Road Fund, Mozambique
[31] Simoes, Irene. 2021, Mar 11. Meeting with Road Fund, Mozambique
[32] https://www.fe.gov.mz/images/relatriodo_prise/Annual_Report_PES-PRISE_2019_EN.pdf

Most road activities implemented by MCC tie certain amounts of funding to requirements related to developing or financing road maintenance funds.[33] In its Compact with MCC, the GOM agreed to ensure compliance of the roles and responsibilities of the Road Fund and ANE, undertake necessary policies to ensure they continued meeting PRISE performance assessment framework indicators, and undertake a program to ensure periodic maintenance of the entire paved road system.[34] An initial review of available data from the GOM show that expenditures by the GOM on the two rehabilitated roads from 2014-2020 have been about $1,012/year-km on the Namialo-Rio Lurio road, and $1,262/year-km on the Rio Ligonha-Nampula road, or a weighted average of $1,114/year-km for the two roads. This evaluation will review these funding levels alongside other data to be collected on the GOM's compliance with maintenance requirements to answer the evaluation as described under EQ 2B below.

In MCC's *Principles into Practic*e report documenting lessons learned from road projects, the authors suggest that maintenance practices be more closely monitored at the compact implementation phase to support sustainability post-compact.[35]

Evaluation Question 2C: Are there factors influencing road transport agencies' maintenance policies and practices that could have been addressed by MCC to improve investment outcomes? What are these factors, and how should they be assessed during project design? [Assumption: Maintenance]

To ensure sustainability of the Roads Project, the Compact named two government agencies responsible for maintenance. The National Roads Agency (ANE), especially its provincial offices, was charged with system management and establishing functional provincial offices to ensure road maintenance. The Road Fund was designed to collect revenue and identify sources of funding for road maintenance, as well as to monitor and evaluate road sectors. The Road Fund collects a fuel levy which enables the road sector to meet funding requirements for routine maintenance. Furthermore, to ensure asset preservation, the Compact further agreed with the GOM to fund periodic maintenance which would occur on a seven-year cycle for paved roads. In the first decade of Roads Rehabilitation, periodic maintenance would be funded by user fees, GOM, and donor funds. After 10 years, periodic maintenance would be funded entirely by user fees.

MCC's *Principles into Practice*[36] series on road investment notes that at the Compact stage, MCC has clear CPs addressing routine and periodic maintenance, which have a robust approach towards sustainability of roads projects. In most cases, MCC noted that these CPs were satisfied but upon visual inspection of the roads post-Compact, some roads did not appear to have received routine or periodic maintenance. There is a need to closely monitor maintenance practices during and after Compact implementation to mitigate sustainability risks.

Evaluation Question 3A: Who is travelling on the road, why, what are they transporting, what are they paying for transport, and how long does it take to move along key routes? [Results: Reduced Transportation Costs (actual), Generated and Diverted Traffic] How does road usage vary by road-user's income and gender?

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[33] Millennium Challenge Corporation, *Principles into Practice, Lessons from MCC's Investments in Roads*, November 2017, p.1

[34] MCC Mozambique Compact, Annex I, p. 13

[35] *Ibid*, p. 7.

[36] Millennium Challenge Corporation, *Principles into Practice, Lessons from MCC's Investments in Roads*, November 2017, page 6 and 7.

Traffic counts, Origin-Destination (O-D) surveys, and axle load surveys are regularly conducted as part of road project feasibility studies. Information from these surveys is often limited to average annual daily traffic (AADT), axle load, and O-D of passenger and freight vehicles. Otherwise, existing evidence mainly targeted residents living near the road construction area instead of directly asking questions to the drivers or passengers using the road. Beneficiaries (road users) from a road improvement project are not identical to those affected by road improvements (residents who resettle or live next to the improved road).

Evaluation Question 3B: Have road usage patterns changed, in terms of who is travelling on the road, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes? [Results: Reduced Transportation Costs (actual), Generated and Diverted Traffic]

ANE conducts annual traffic counts at 266 locations around the country. An O-D survey was conducted in November/December 2009 by SMEC in tandem with a traffic count at four stations on the Nampula-Rio Ligonha segment, prior to construction work. The O-D interview location was at Rio Ligonha and included roadside interviews of vehicle drivers.[37] The Road Fund and ANE shared that the MCC funded roads are used extensive for trade in Malawi to access the Nacala port and Cabo Delgado. The traffic on these roads have increased and there has also been increased construction of commercial establishments along the road.

Axle load surveys are regularly conducted as part of road project feasibility studies. Information from these surveys is often limited to average annual daily traffic (AADT), axle load, and O-D of passenger and freight vehicles. Otherwise, existing evidence mainly targeted residents living near the road construction area instead of directly asking questions to the drivers or passengers using the road. Beneficiaries (road users) from a road improvement project are not identical to those affected by road improvements (residents who resettle or live next to the improved road).

Mozambique scored a 90 out of 141 on the road connectivity index in WEF's 2019[38] Global Competitiveness Report. The first of the two elements that comprise the Road Connectivity Index is: "a measure of the average speed of a driving itinerary connecting the 10 or more largest cities in an economy accounting for at least 15% of the economy's total population."[39] Mozambique's 2019 ranking on this indicator increased from the previous year by 68 points, which could indicate an overall trend of decreasing average travel times on Mozambique's roads. Mozambique also shows an increase in the quality of road infrastructure, up by about 23.4 points from the previous year.

Although the case linking rehabilitated roads to improved living standards may seem straightforward, findings on distributive impacts remain ambiguous. While studies of impacts of rural road development have generally found that they can lead to improvements in household income and access to services and markets,[40] strong positive correlations between improvements in roads and improvements in living standards are case-specific. For example,[38] the roads evaluation in Armenia found that households that live around rehabilitated roads had improved

[37] SMEC, Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road –Phase 2: Detailed Design– Volume – 2: Main Report, Chapter 3, p. 6

[38] http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

[39] WEF, p. 617.

[40] Iimi, A. et al. (2015). Social and Economic Impacts of Rural Road Improvements in the State of Tocantins, Brazil. Policy Research Working Paper 7249. World Bank Group.

market access but did not exhibit similar improvement in access to social services since the local population did not use regional roads to travel to social services. The nature and degree of benefits derived from road rehabilitation are often indirect and depend on multiple factors, such as differences between before and after conditions, land quality in surrounding areas, levels of motorization,[41] strategic location,[42] maintenance, etc. One also has to consider the impact of roads rehabilitation by gender and the impact on vulnerable populations.

Because effects are influenced by various existing conditions and investments beyond road infrastructure, distribution of impacts is not necessarily spread evenly. From an equity perspective, much seems to depend on the access to services and markets that the rehabilitated roads provide by poorer populations, although little systemic analysis has been conducted on this issue.[43] Khandker and Koolwal found that rehabilitating rural roads in Bangladesh increased non-agricultural wage employment among target households.[44] On the other hand, a 2002 study found that the benefits of providing better road access to markets in Nepal were not large enough or targeted efficiently enough to greatly reduce poverty and income inequality.[45] Parada finds that even after many years of investments in road rehabilitation by donors, evidence is limited on the heterogeneous distribution of benefits or about how much they reduce transport costs, generate new market activity, and affect input and output prices.[46]

Evaluation Question 4: Given the existing transportation market structure, what portion of VOC savings will be passed on to consumers of transportation services? If not all savings are passed on, how could this project have cost effectively addressed these inefficiencies? [Result: Reduced Transportation Costs]

When transport service providers are operating under free market conditions, firms behave strategically when determining their prices, knowing that competitors do the same. As a result, if a firm raises its price this can lead to an increase in profit margin but a decrease in traffic which then can lead to a traffic increase for the competitors (in the same or another mode) who may want in turn to set slightly higher prices to increase their margins. This will continue until there is a Nash equilibrium in the marketplace.[47] Barriers to prevent markets from freely operating in this manner includes the influence of cartels and governments regulating pricing. The presence of such barriers may prevent vehicle operating cost savings from being passed down to transport service consumers.

In a World Bank report by Teravaninthorn and Raballand (T&R), "Transport Prices and Costs in Africa: A Review of the Main International Corridors,"[48] the authors find that the transport of

[41] Escobal, Javier and Carmen Ponce. 2002. "The Benefits of Rural Roads: Enhancing Income Opportunities for the Rural Poor." GRADE Working Paper 40.
[42] Shrestha, S. A. (2012). Access to the North-South roads and farm profits in rural Nepal. Working Paper.
[43] Calderon, C. & L. Serven. (2014). Infrastructure, Growth, and Inequality: An Overview. World Bank Group. Working Paper 7034.
[44] Khandker, S.R., & G.B. Koolwal (2010) "How Infrastructure and Financial Institutions Affect Rural Income and Poverty: Evidence from Bangladesh." The Journal of Development Studies 46(6), 1109-1137.
[45] Jacoby, H. (2000). Access to markets and the benefits of rural roads. The Economic Journal, 110(465), 713–737 in Parada, J. (2016). Access to modern markets and the impacts of rural road rehabilitation: Evidence from Nicaragua
[46] Parada, J. (2016). Access to modern markets and the impacts of rural road rehabilitation: Evidence from Nicaragua
[47] Ivaldi, Marc & Vibes, Catherine, 2005. "Intermodal and Intramodal Competition in Passenger Rail Transport," IDEI Working Papers 345, Institut d'Économie Industrielle (IDEI), Toulouse
[48] Teravaninthorn, S., & Raballand, G. (2009). Transport prices and costs in Africa: a review of the main international corridors. World Bank Publications.

freight between Sahelian countries and their ports features prices that are significantly higher than the underlying costs. This finding suggests that large profits are funneled to rent-seeking road-transport cartels benefitting from oligopolies. T&R argue that unless governments take steps to remove the structural distortions of the trucking market, there is no point in investing to reduce road-transport costs. The authors claim that the cartels will capture the benefits from lowered costs while the prices will remain the same for the users. In India, truckers' unions have also fixed freight prices restricting pass-through of cost savings and choking out competition in the market.[49]

There is not sufficient information available on the Mozambique public transportation sector, nor is there evidence on the impact of road improvement on public transportation prices readily available. The ADB funded Vanduzi-Changara road predicted an ERR of 29% over 20 years, however the report did not specify whether these cost savings were translated in lower transportation fares.

II.5.2 Gaps in Literature

Evaluation Question 0

Gaps in literature are not applicable for Evaluation Area 0.

Evaluation Question 1

Much of the available information on economic analyses of road investments are ex-ante estimates conducted as part of feasibility studies or a selection process to choose the road to be improved. Without ex-post economic analysis, it is difficult to understand whether the road project actually generated the economic return that was initially anticipated.

Evaluation Question 2A

MCC encourages the adoption of best practices for maintenance by road authorities in partner countries.[50] The current available literature on this topic does not include countries' standard operating procedures or risk mitigation policies with regards to maintenance. The addition of such documents to the literature would contribute to sustainability of investment efforts, which are related to road maintenance.

Evaluation Questions 2B and 2C

In MCC's *Principles into Practic*e report, the authors note that "the use of CPs to incentivize road maintenance and ensure the sustainability of road investments was not universally effective."[51] Future investments may wish to consider other approaches focused on promoting post-investment maintenance and document the outcome(s) of these efforts to contribute to the literature on this topic.

Evaluation Questions 3A and 3B

Much of the existing evidence has been limited because its definition of beneficiaries pertained to population residing close to the improved road segment. This definition limits development of literature on those who actually use the road, which may differ from those who reside next to road.

[49] Babu Chennupati, D., & Mouly Potluri, R. (2011). A viewpoint on cartels: an Indian perspective. International Journal of Law and Management, 53(4), 252-261.
[50] Millennium Challenge Corporation, *Principles into Practice, Lessons from MCC's Investments in Roads*, November 2017, p.13
[51] *Ibid*, p. 5

Therefore, while there is ample, yet inclusive, evidence on benefits of road improvement, it is not helpful in understanding the change of road users before and after the road improvement. In addition, much of the available information is limited to road users prior to road improvement as governments and donors are less inclined to learn about them after the road improvement.

MCC's focus on defining the road users as beneficiaries of road infrastructure projects has shifted the evaluations to examine the road user patterns and changes over time. For the evaluation, information from the O-D survey and a traffic count is available from the feasibility study, but this is limited to AADT and O-D, not providing other details on the road users such as Public Transport User (PTU) surveys and Travel Time surveys, which if conducted during the feasibility study, would provide a richer comparison between pre and post road rehabilitation. This would help in ascertaining the benefits to actual road users and not just the population residing in the vicinity of the rehabilitated roads.

Evaluation Question 4

Teravaninthorn and Raballand find that there can be a strong disconnect between transport costs and the actual transport prices. Especially for Central Africa, the authors found that higher transport prices are reported for roads in better condition, which is counterintuitive.[52] The authors conclude that the high prices are due to informal market-sharing agreements. More detailed information needs to be collected during the feasibility studies in VOC surveys that delineate transports costs from transport prices. Also, while conducting the feasibility studies and predicting the ERR for the rehabilitated road, it is imperative to ascertain and predict whether the savings in cost will translate into savings in transportation fares.

II.5.3 Policy Relevance of the Evaluation

Evaluation Question 0

The response to Evaluation Question 0 will help to inform MCC's future design of road projects.

Evaluation Question 1

The evaluation will be one of the few instances in which an ex-post economic analysis of a road investment is conducted based on rigorous data collection. Evaluation Question 1 will contribute to the literature by providing evidence of the limited number of ex-post economic analysis conducted for investments in road rehabilitation. The economic analysis of a public infrastructure investment is critical for assessing whether the benefits accruing to the targeted beneficiaries (reduced transportation costs and maintenance costs) are higher than the capital and recurrent costs incurred for the construction and maintenance of the infrastructure. The economic return of the planned road investment based on the evaluation of road users' and road agencies' net savings, evaluated in economic prices, is an appropriate tool consistent with the policy of selecting the investments in public infrastructure.

Evaluation Question 2A

Evaluation Question 2A will shed light on the maintenance practices that have been ongoing since the completion of the RRP.

Evaluation Question 2B

[52] *Ibid.,* p. 41

Evaluation Question 2B will assess whether the requirements set by MCC for maintenance practices in Mozambique post-Compact were sufficient.

Evaluation Question 2C

Evaluation Question 2C will inform MCC and other development partners of additional factors that can influence road maintenance practices and policies, so such factors can be considered in future investments.

Evaluation Questions 3A and 3B

Evaluation Questions 3A and 3B will provide information on the actual road users that benefit from the road investment projects. The evaluation questions are intended to shine light on who benefits and the details of their choices, including the rationale for choosing to drive on the road and what they are transporting. Evaluation Question 3B will help policymakers understand how the road usage changes before and after road improvement, in addition to the total volume of vehicles on the road.

Evaluation Question 4

Evaluation Question 4 will inform MCC and other development partners' understanding of who benefits from investments in road rehabilitation. The evaluation question is intended to shine light on how the benefits are distributed among road users.

III. EVALUATION DESIGN

III.I EVALUATION QUESTIONS

The evaluation will address the following evaluation areas:

Evaluation Area 0 examines whether the RRP was implemented according to plan. The analysis will focus on highlighting any ways that implementation deviated from the original Compact design to fully understand how the RRP was implemented. The evaluation team will review program documents to identify any changes made to the original design.

Evaluation Area 1 a performance evaluation to test whether the MCC-funded road achieved its objective of reducing transportation costs. The evaluation will employ the Highway Development and Management (HDM)-4 model to answer this question, an analytical tool developed by the World Bank. The evaluation will compare the projected magnitude of changes with actual changes for indicators where ex-ante projections are available. The post-Compact cost-benefit analysis (CBA) will re-evaluate the validity of the initial assumptions made prior to the Compact on savings to the road agency and road users, as well as the economic viability of the RRP.

Evaluation Area 2 will evaluate the road maintenance regime within Mozambique to test the sustainability of improvement in road infrastructure. Examining the political and economic factors shaping road maintenance decisions and practices will improve MCC's assumptions of post-Compact maintenance and project-life assumptions about its infrastructure investments. It will also evaluate whether requirements related to road maintenance funding, which were included by MCC as part of the project, were fulfilled and if so, what their effects were after the Compact has ended. It will also examine whether there are factors influencing road transport agencies' maintenance policies and practices that could have been addressed by MCC to improve investment outcomes.

Evaluation Area 3 is a study of road users to understand the type of beneficiaries from the RRP. The data collected for Evaluation Area 3 will inform the HDM-4 model. Information such as the cost and duration of trips and value of goods being transported will be analyzed. This evaluation area is also intended to understand the theory of change between reduced transportation costs and the overall project goal.

Evaluation Area 4 is an analysis of the transportation market structure. This evaluation area will analyze transportation market structure, both formal and informal, to understand how cost savings from road improvements have passed on to transport consumers who do not own their own vehicles. The analysis of the formal and informal institutions of the transportation market will inform whether VOC savings are passed on to road users who do not own their own vehicle, such as farmers transporting their goods to market and public transportation users.

Below are the evaluation questions for each evaluation area:

Evaluation Area 0: Project Design and Implementation

0) Was the project implemented according to plan? [Result: Road Rehabilitation]

Evaluation Area 1: Engineering Analysis and Economic Model

1) Did the project reduce transportation costs? Was the magnitude of this reduction the same as was expected in the MCC investment decision CBA for the same exposure period? Why or why not? Was the MCC investment to achieve this reduction cost-effective

(defined as exceeding MCC's 10% economic rate of return hurdle rate)? Is the current Economic Rate of Return (ERR) for the project different than the investment-decision ERR? If so, why? How could the project have been designed to result in a higher ERR? [Result: Reduced Transportation Costs]

Evaluation Area 2: Maintenance

2A) What are the relevant road authority's current maintenance practices? What is the likelihood that MCC's investment will remain adequately maintained for the life of the investment? Additionally, what maintenance regime (presented graphically, with time on the x axis and International Roughness Index (IRI) on the y axis) reflects current practices and will therefore be used in HDM-4? What maintenance practices most influenced your selection of this regime? Finally, there was some debate during compact re-scoping as to whether the counterfactual should include periodic maintenance or not. Which counterfactual is most likely, and what evidence do you have to support this choice? [Assumption: Maintenance]

2B) The Mozambique Compact included text requiring policy, legal and regulatory reforms related to maintenance, as listed on Annex I - page 13 of the agreement. What were the effects on road maintenance of these requirements? [Assumption: Maintenance]

2C) Are there factors influencing road transport agencies' maintenance policies and practices that could have been addressed by MCC to improve investment outcomes? What are these factors, and how should they be assessed during project design? [Assumption: Maintenance]

Evaluation Area 3: Road Usage Patterns

3A) Who is traveling on the road, why, what are they transporting, what they are paying for transport, and how long does it take to move along key routes? [Result: Reduced Transportation Costs, Generated Traffic, Diverted Traffic]

3B) Have road usage patterns changed, in terms of who is traveling on the road, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes? [Result: Reduced Transportation Costs, Generated Traffic, Diverted Traffic]

Evaluation Area 4: Transportation Market Structure

4) Given the existing transportation market structure, what portion of transportation cost savings will be passed on to consumers of transportation services? If not all savings are passed on, how could this project have cost effectively addressed these inefficiencies? [Result: Reduced Transportation Costs]

Individual evaluation areas are interwoven as outlined in Figure 4 below. In advance of evaluating the RRP, the team will investigate how the project was implemented (Evaluation Area 0). Evaluation Area 1 is designed to use an economic analysis model (HDM-4) to estimate the reduction in transportation costs and maintenance costs and compare these benefits against the total cost of the RRP investment to determine the cost-effectiveness of the investment. It also includes analysis of road conditions, as improved road quality lowers costs. Evaluation Areas 3 and 4 are intended to understand the theory of change beyond the objective of reduced transportation costs, on the way to "poverty reduction through economic growth." Evaluation Area 2 is intended to provide qualitative information on the maintenance regime to shape the understanding of its

effect on the evaluation based ERR of the MCC-funded road infrastructure projects. It is further intended to determine whether the requirements set by MCC regarding maintenance post-Compact are effective and sufficient, and to assess whether there are factors influencing road transport agencies' maintenance policies that MCC could have addressed at the project design phase to improve investment outcomes. The five evaluation areas, collectively, inform MCC on its future project design, monitoring, and implementation of roads project and/or other large infrastructure projects.

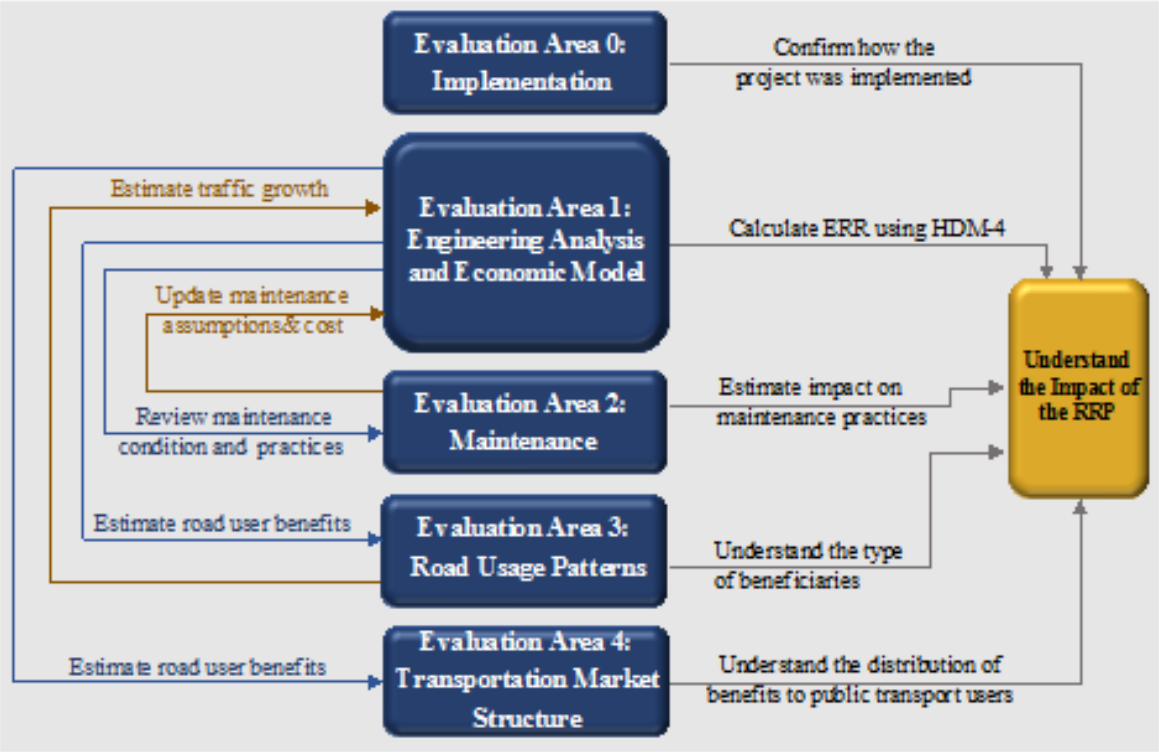

Figure 4 Integration of Evaluation Areas

III.2 EVALUATION DESIGN OVERVIEW

Evaluation methodology is determined by the evaluation question. Table 2 presents the evaluation type, evaluation design methodology, and data collection methods as appropriate for each evaluation question.

Table 2 Summary of Evaluation Design Overview

Evaluation Question (EQ)	Evaluation Type	Evaluation Methodology	Data collection method		Did IMC Collect Data	IDG Recommendation for Data Collection
			Baseline	Endline		
EQ 0	Performance Evaluation	Ex-post	N/A	KII	Yes	IDG will use some of IMC's KII and conduct a few fresh KIIs.

Evaluation Question (EQ)	Evaluation Type	Evaluation Methodology	Data collection method		Did IMC Collect Data	IDG Recommendation for Data Collection
			Baseline	Endline		
				1.MCC Project Documents, 2.ANE and Road Fund Documents,	N/A	N/A
EQ 1	Performance Evaluation	Modelling	1.MCC Project Documents, 2.Road Fund Documents,	**Primary Data Collection**	Yes	IDG will use some of IMC's data and conduct data collection as well
				• Manual traffic count	Yes	IDG will re-do part of the MTC since there is a variance between ANE and IMC data. More details in section V.3
				• O-D survey	Yes	IDG will conduct O-D survey anew since IMC did not conduct it for passenger vehicles. More detail in Section V.4.
				• VOC survey	No	IDG will use ANE and IMC data.
				• Road roughness study	Yes	IDG will conduct roughness study again with proper calibration at 100 m intervals.
				• Road condition study	Yes	IDG will not conduct this study. IDG experts will estimate distress levels via visual assessment during the road roughness study.
				1.MCC Project Documents,	N/A	N/A

Evaluation Question (EQ)	Evaluation Type	Evaluation Methodology	Data collection method		Did IMC Collect Data	IDG Recommendation for Data Collection
			Baseline	Endline		
				2.Road Fund Documents, 3.ANE Documents		
EQ 2A	Performance Evaluation	Ex-post	N/A	KIIs	Yes	IDG will conduct KII using a more detailed questionnaire to assess maintenance practices.
				1.MCC Project Documents, 2.Road Fund Documents, 3.ANE Documents	N/A	N/A
				Road roughness study	Yes	IDG will conduct roughness study again with proper calibration at 100 m intervals.
				Road condition study	Yes	IDG will not conduct this study. IDG will estimate distress levels via the road roughness study.
EQ 2B	Performance Evaluation	Pre-post	1.MCC Project Documents, 2.Road Fund Documents,	KIIs	Yes	IDG will conduct KII using a more detailed questionnaire to assess maintenance practices.
				1.MCC Project Documents, 2.Road Fund Documents, 3.ANE Documents	N/A	N/A

Evaluation Question (EQ)	Evaluation Type	Evaluation Methodology	Data collection method		Did IMC Collect Data	IDG Recommendation for Data Collection
			Baseline	Endline		
EQ 2C	Performance Evaluation	Ex-Post	N/A	KIIs	Yes	IDG will conduct KII using a more detailed questionnaire to assess maintenance practices.
				1.MCC Project Documents, 2.Road Fund Documents, 3.ANE Documents	N/A	N/A
EQ 3A	Performance Evaluation	Ex-post	N/A	O-D survey	Yes	IDG will conduct O-D survey anew since IMC did not conduct it for passenger vehicles. More detail in Section V.4.
				Public Transport User Survey	No	IDG will conduct PTU survey to be able to address EQs 3A and 3B.
				Travel time study	No	IDG will conduct this survey in order to answer EQs 3A and 3B
EQ 3B	Performance Evaluation	Pre-post	1.MCC Project Documents, 2.Road Fund Documents,	Manual Traffic Count	Yes	IDG will re-do part of the MTC since there is a variance between ANE and IMC data. More details in section V.3
			O-D Survey (retrospective baseline)	O-D survey	Yes	IDG will conduct O-D survey anew since IMC did not conduct it for passenger vehicles. More

Evaluation Question (EQ)	Evaluation Type	Evaluation Methodology	Data collection method		Did IMC Collect Data	IDG Recommendation for Data Collection
			Baseline	**Endline**		
						detail in Section V.4.
			Public Transport User Survey (retrospective baseline)	Public Transport User Survey	No	IDG will conduct PTU survey to be able to address EQs 3A and 3B
EQ 4	Performance Evaluation	Ex-post	N/A	1.MCC Project Documents, 2.Road Fund Documents, 3.ANE Documents	N/A	N/A
				O-D survey	Yes	IDG will conduct O-D survey anew since IMC did not conduct it for passenger vehicles. More detail in Section V.4.
				Public Transport User Survey	No	IDG will conduct PTU survey to be able to address EQ 4.

MCC's Independent Evaluation Management Guidance[53] defines two main types of evaluation: impact and performance. Based on MCC's definition of performance evaluations, this evaluation is considered a performance evaluation[54] for all of the evaluation questions.

With the exception of EQ 1, EQ 2B, and EQ 3B, all other evaluation questions are ex-post evaluations where post-Compact data will be used to answer the evaluation questions. EQ 1 will not be comparing baseline and endline values directly but rather analyzing the different scenarios

[53] MCC Independent Evaluations Management Guidance – External, Version: February 2020.

[54] In its February 2020 guidance, MCC defines (a) performance evaluation on page 3 as "*estimat(ing) the contribution of MCC investments to changes in outcome trends, when formal measurement of a counterfactual is not feasible. Performance evaluations cannot attribute outcome changes to specific causes. However, they often provide crucial insight they often provide crucial insights into strengths or weaknesses in program implementation through critical empirical and analytic assessment of the measurable components of the program's intermediate and ultimate outcomes. They can often identify clear opportunities to improve program implementation and investment decisions, even when they cannot explicitly estimate how an investment might have contributed to changes in beneficiary incomes.*"

with and without the RRP. The "without" scenario will be based on the baseline data. The evaluation will use modelling based on previously gathered data as well as through additional data collection to answer EQ 1. EQ 2B will employ pre-post comparison to examine the effects of the Compact requirements. The road condition data and recollection of KIIs will serve as a retrospective baseline. EQ 3B will employ pre-post comparison to examine the changes that took place before and after the road improvements. The O-D and PTU Surveys, in which interviewees will be asked questions about road usage prior to the road improvement, will serve as a retrospective baseline.

Detailed primary and secondary data collection methodology will be discussed in the following sections for each evaluation question and sub-question. The evaluation will use a mixed-methods approach, employing both quantitative and qualitative methods for the performance evaluation.

Table 3 Detailed Evaluation Design Overview

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
Evaluation Question 0: Was the project implemented according to plan?							
Output: MCC Road Reconstruction and Rehabilitation	List of deviations from original Compact design	N/A	N/A	N/A	N/A	**Secondary Sources** • MCC Project Documents (design reports, as-built drawings, End of Compact Review)	• Information obtained from the secondary sources will be triangulated with information obtained from the key informant interviews.
						Key Informant Interviews (remote) (MCC, ANE, Road Fund, previous MCA staff if possible)	• Information obtained from the KIIs will be triangulated with information obtained from the secondary sources
Evaluation Question 1: Did the project reduce transportation costs? Was the magnitude of this reduction the same as was expected in the MCC investment decision CBA for the same exposure period? Why or Why not? Was the MCC investment to achieve this reduction cost-effective? Is the current Economic Rate of Return (ERR) for the project different than the investment-decision ERR? If so, why? How could the project have been designed to result in a higher ERR?							
Outcome: Reduced transportation costs (travel time and VOCs) & **Outcome**: Reduced maintenance costs	Average Annual Daily Traffic of the MCC-funded road sections (*R-10 MCC Common Indicator list*)	Number	The average number and type of vehicles per day, averaged over different times (day and night) and over different seasons to arrive at an annualized daily average. Minimum vehicle class categories are non-motorized traffic, motorcycles, passenger cars, light trucks, medium/heavy trucks, mini-buses, and heavy buses. For each traffic count station, note the day(s) of the week collected, hours collected each day, and the geo-code.	Motorized AADT derived from MTC conducted for a week, 16-hour period for 5 days and two 24-hour period. (1) Rio Ligonha to Nampula Road (Nov-Dec 2009)[55] **At Nampula, Km 98.6:** 13299 (9691) **At Namaita, Km 66.3:** 1153 (827) **North of Muruppula at Km 27.4:** 471 (387) **At Rio Ligonha, Km 0.0:** 278 (260) Note: Figures in bracket are excluding motorcycles (2) Namialo - Rio Lurio Road (Oct 2009 and July 2010)[56] **Namialo – Nacaroa:** 696 (465) **Netia – Nacaroa:** 596 (454) **Nacaroa – Alua:** 495 (333) **Alua – Namapa:** 440 (327) **Namapa – Rio Lurio:** 370 (290)	AADT estimates from ANE (excluding MC): (1) Rio Ligonha to Nampula Road (2013) **Nampula:** 1655 **Namaita:** 915 **North of Murupula:** 860 **Muruppula – Rio Ligonha:** 961 (2) Namialo - Rio Lurio Road **Namialo - Nacaroa:** 1419 **Netia – Nacaroa:** 1211 **Nacaroa – Alua:** 821 **Alua – Namapa:** 583 **Namapa - Rio Lurio:** 524	**Use IMC counts of 2019 and Partial New Manual Traffic Count survey** • Survey days: 3 days (2 weekday & 1 weekend) 24 hours • Survey period[57]: July 2022 • Sample unit: Motorized and non-motorized vehicles on the project road sections • Target respondents: N/A • Adjustment: seasonal traffic variation from ANE • Instrument: paper-form	• Pilot test to be conducted • Double entry of data collected to ensure accurate data entry • Data entry using a software with built-in quality checks
	Vehicle occupancy – to be ascertained via Average Annual Daily Traffic (*R-10 MCC Common Indicator list*)	Number	Number of average occupants per vehicle derived from the average number and type of vehicles per day, averaged over different times (day and night) and over different seasons to arrive at an annualized daily average. Minimum vehicle class categories are non-motorized traffic, motorcycles, passenger cars, light trucks, medium/heavy trucks, mini-buses, and heavy buses.	Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 O-D survey conducted in November 2009: Motorcycle – 1.3 Car – 3.8 Pickup/Van – 5.5 Minibus - 14 Large bus – 40 (Methodology is unknown)	Not available	**Origin-Destination survey** • Sample unit: Motorized vehicle on the Nampula-Rio Ligonha and Namialo-Rio Lurio roads • Target respondents: Driver of a motorized vehicle and a randomly selected passenger of the vehicle, with different modules for drivers and passenger origin and destinations.	• Back-translation and pre-test of questionnaire, and pilot test to be conducted. • Data collected on electronic devices, if possible, to minimize data entry errors • Call-back of 10% respondents to verify data collected

[55] Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010
[56] Final Detailed Engineering Design Report –Revision 1: VOLUME 2: MAIN REPORT – PART A: ROADWORKS, Scott Wilson Ltd., Feb 2011
[57] The feasibility study traffic counts were in October/November. Traffic is closer to annual average in the months of July to October based on seasonal variation indicated in feasibility study.

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
			For each traffic count station, note the day(s) of the week collected, hours collected each day, and the geo-code.			IDG will collect data on trip purpose as part of the OD survey.	
	Trip purpose (business, leisure or other) (*R-19 & R-20 MCC Common Indicator list*)	Percentage	**R-19:** Number of road users travelling for business (work or commuting to/from work) (numerator) out of the total number of road users travelling (denominator), expressed as a percentage. Disaggregation: Key routes **R-20:** Number of road users travelling for leisure (visiting family/friends, entertainment) (numerator) out of the total number of road users travelling (denominator), expressed as a percentage. Disaggregation: Key routes	Not available	Not available		
	Travel time (*R-17 MCC Common Indicator list*)	Minutes	Average amount of time it takes to travel a key route. •Disaggregation: Vehicle type (at a minimum: Non-motorized traffic, Motorcycles, Passenger cars, Light trucks, Medium/heavy trucks, Mini-buses, and Heavy buses); Key routes	Not available	Not available	IDG will conduct Travel Time study as part of data collection.	
	Cargo value (*R-22 MCC Common Indicator list*)	USD	Average value in US dollars of cargo being transported in a vehicle using the road. Disaggregation: Trade type (Import/Export/Domestic); Key routes; Cargo type (International Standard Industrial Classification of All Economic Activities (ISIC) Broad Structure); Direction of travel	Not available	Not available	Cargo value will be derived from value reported in OD survey. The time value of cargo delay will be estimated using the approach suggested in HDM-4 manual which is to estimate the time value based on interest cost of the cargo value.	The cargo value will be cross verified by the share of commodity type, quantity assessed and market value based OD survey results.
	Equivalent standard axle	ESAL	Summation of equivalent 18,000 lbs (or 18 kips, or 80 kN) single axle	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road –	Not available	An axle load survey will not be conducted under this evaluation.	

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
	loads (ESAL) factor		loads used to combine mixed traffic to standard loads	Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 ESAL = 2.3 – 13.1·10^6 2. Final Detailed Engineering Design Report – Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 ESAL = 3.0 – 5.7 ·10^6		**Secondary sources:** The team will use the results of AADT survey and load equivalency factors from the SAATC Pavement Design Guide	
	Cost of Transportation (*R-23 MCC Common Indicator list*)	USD/km	The estimated cost of using the road in USD per kilometer, by vehicle type. Disaggregation: Vehicle type (at a minimum: Non-motorized traffic, Motorcycles, Passenger cars, Light trucks, Medium/heavy trucks, Mini-buses, and Heavy buses); Investment type (Construction/Rehabilitation/Periodic maintenance/Improvement)	MCC HDM-4 Model developed based on 2010 feasibility study during compact re-scoping exercise.	MCC HDM-4 Model used in closeout analysis and ANE HDM-4 model	**Targeted Vehicle Operating Cost survey** Latest VOC data available with ANE was calibrated in 2016. This data updated to the analysis year by ANE will be used.	• Data collected from the interviews will be verified by comparing the responses among the target respondents.
	Kilometers of road network with evidence-based maintenance execution (*R-28.1 MCC Common Indicator list*)	Percentage	Number of kilometers of executed maintenance that is supported by a network prioritization Disaggregation: None	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 2. MCC HDM-4 Model	Not available	**Secondary Sources** MCC Project Documents (design reports, as-built drawings, End of Compact Review) sources from the Road Fund and ANE including recently bid road contract unit prices	Data will be compared with unit costs from other countries to assess the legitimacy of the data collected
	Road physical parameters for HDM-4	m^2 or m or #/km for AC (flexible) pavement	Roadway width, geometry, drainage and speed reduction factors etc.	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 [1] Final Detailed Engineering Design Report – Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011	**As-built drawing**	**As-built drawings**	Data will be extracted from the as-built drawings by the HDM-4 Specialist. Data will be verified by the Team Leader and Road/Pavement Specialist
	International Roughness Index (IRI) (*R-9 MCC Common Indicator list*)	m/km	The measure of the roughness of the road surface, in meters of height per kilometer of distance traveled. This should be measured in the outer wheel path of each lane by a Class 3 or better (Class 1, Class 2) device. The device, device class, standard (for example: "ASTM" - American Standard for Testing and Materials) and data processing software used must be specified. The device should be validated for precision and bias prior to measurement. Data should be reported at 10m intervals.	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 IRI_{avg} = 3.9 m/km IRI_{range} = 2.1 – 9.3 m/km According to the rescoped M&E Plan (V4, Dec. 2013) the baseline IRI was 3.7 – 4.0 m/km.	Rio Ligonha to Nampula Road: IRI_{avg} = 2.6 m/km Namialo – Rio Lurio road IRI_{avg} = 3.3 m/km	**Road Roughness survey** The 2020 roughness survey was conducted using a Class 3 Roughmeter III device. However, the calibration procedure included only repeatability testing on one reference section and was not validated over a range of IRI values. In addition, IRI values are reported at 100-m increments. Therefore, it is necessary to perform IRI survey using a Class 1 device, following the calibration of device on	Calibration: Sample 6 test sections (each 300-m long) covering a range of expected roughness; using dipstick and/or topographical survey to determine actual IRI, and plotted against the profiler's measures to determine a line of best fit to derive calibration equation. Test repeatability at each test section (run 5 times) at least two speeds within the standard range of vehicle speed on the road.

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
			A lower value means a smoother road. Typically, a paved road will have an IRI of 3m/km or lower, while an impassible road will have an IRI of greater than 14m/km. Disaggregation: Road class (Primary/Secondary/Tertiary)	2. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 (Namialo to Metoro road) IRI = 3.53 – 3.96 m/km (based on survey performed with laser profiler in September 2009) According to the rescoped M&E Plan (V4, Dec. 2013) the baseline IRI was 8.0 m/km.		reference sections with range of IRI values.	
	Road condition parameters for HDM-4	m^2 or m or #/km for AC (flexible) pavement	Area with wide cracking, area with all cracking, area potholed, mean rut depth etc.	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 2. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 Detailed road condition data provided in the report.	Detailed road condition data is available	**Road Condition study** • Survey period: same time as road roughness study • Equipment: The Road/Pavement Engineer will conduct a visual inspection of distress areas that were identified during the road roughness survey • Interval: select sections identified during the road roughness survey	Level of maintenance performed cross-checked with existing data on maintenance performed
	AC pavement: Structural Number (SN)	Number	Index representing the structural strength of pavement	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010, Appendix F2 – FWD test report Detailed deflection data are available. 2. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 FWD $d_{o,avg}$ = 389 µm - 1405 µm	Rio Ligonha to Nampula Road: FWD $d_{o,avg}$ = 352 µm Namialo – Rio Lurio road FWD $d_{o,avg}$ = 274 µm **As-Built Drawing** • Drawings are available.	The roads are in good structural condition, the evaluation team will use as-built drawings and deflections measures provided in the data collection report.	Primary data collection not required based on preliminary analysis of the roads. Data will be extracted from the as-built drawings by the Road/Pavement Engineer. Data will be verified by the Team Leader and HDM-4 Specialist
	AC pavement: Layer thickness and coefficients	mm	Thickness of surface, base and sub-base layers	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 CBR = 2% - 45%, CBR_{avg}=15%	Rio Ligonha to Nampula Road: Surface layer: DBST or AC 40 mm Namialo – Rio Lurio Road: Surface layer: DBST 2015 Survey data: Rio Ligonha to Nampula Road:	The roads are in good structural condition, the evaluation team will use as-built drawings and deflections measures provided in the data collection report.	Primary data collection not required based on preliminary analysis of the roads. Data will be extracted from the as-built drawings by the Road/Pavement Engineer. Data will be verified by the Team Leader and HDM-4 Specialist
	California Bearing Ratio (CBR)	Percentage	Strength of non-stabilized subgrade				

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
				2. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 $CBR_{10\%-ile}$ = 14% - 35% (DCP) $CBR_{10\%-ile}$ = 5% - 16% (Lab) Layer coefficients = 0.20 (DBST) – 0.35 (AC)	CBR = 16.6% - 28.7%, CBR_{avg}=21.7% Namialo – Rio Lurio road CBR = 14.0% - 31.6%, CBR_{avg}=20.2%		
Evaluation Question 2A: What are the relevant road authority's current maintenance practices? What is the likelihood that MCC's investment will remain adequately maintained for the life of the investment? Additionally, what maintenance regime (presented graphically, with time on the x axis and International Roughness Index (IRI) on the y axis) reflects current practices and will therefore be used in HDM-4? What maintenance practices most influenced your selection of this regime? Finally, there was some debate during compact re-scoping as to whether the counterfactual should include periodic maintenance or not. Which counterfactual is most likely, and what evidence do you have to support this choice? [Assumption: Maintenance]							
Assumption: Maintenance	Requested annual maintenance budget (*R-29.2 MCC Common Indicator list*)	USD	Total amount requested for road maintenance from the central government by the national road maintenance agency for the year (2014-2021). Disaggregation: Maintenance type (Routine/Periodic/Emergency)	N/A	N/A	**Secondary Sources** • Review available secondary sources from ANE and the Road Fund between 2014 to 2021	• Information obtained from the secondary sources will be triangulated with information obtained from the key informant interviews
	Annual road maintenance funds allocated (*R-29.1 MCC Common Indicator list*)	USD	Definition: Amount of road maintenance funds allocated by the central government to the road maintenance agency for the year (2014-2021). Disaggregation: Maintenance type (Routine/Periodic/Emergency)	N/A	N/A	**Secondary Sources** • Review available secondary sources from ANE and the Road Fund between 2014 to 2021	
	Annual road maintenance budget spent (*R-30.1 MCC Common Indicator list*)	USD	Amount of road maintenance budget spent by the road maintenance agency for the year Disaggregation: Maintenance type (Routine/Periodic/Emergency)	N/A	N/A	**Secondary Sources** • Review available secondary sources from ANE and the Road Fund between 2014 to 2021	
	Evidence based Maintenance Planning (*R-27 MCC Common Indicator list*)	Percentage	Number of kilometers of the whole road network for which network prioritization data is complete (numerator) over total kilometers of road in the whole network (denominator), expressed as a percentage. Disaggregation: None	N/A	N/A	**Secondary Sources** • Review available secondary sources from ANE and the Road Fund.	
	International Roughness Index (*R-9 MCC Common Indicator list*)	IRI (m/km)	IRI can be interpreted as the output of an idealized response-type measuring system, where the physical vehicle and instrumentation are replaced with a mathematical model [ASTM E1926 - 08(2021)]	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 IRI_{avg} = 3.9 m/km	Rio Ligonha to Nampula Road: IRI_{avg} = 2.6 m/km Namialo – Rio Lurio road IRI_{avg} = 3.3 m/km	**Road Condition study and Road Roughness study** Use data collection under Evaluation Question 1	• Use data collection under Evaluation Question 1

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
				2. Final Detailed Engineering Design Report – Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 IRI = 3.5 – 3.9 m/km			
	Road Conditions Study (percentage of pavement surface cracked)	Cracking Percentage	Area with wide cracking, area with all cracking, area potholed, mean rut depth etc.	1. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 2. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 Detailed road condition data provided in the report.	Detailed road condition data is available	**Road Condition study** • Survey period: same time as road roughness study • Equipment: The Road/Pavement Engineer will conduct a visual inspection of distress areas that were identified during the road roughness survey Interval: select sections identified during the road roughness survey	• Level of maintenance performed cross-checked with existing data on maintenance performed
Evaluation Question 2B: The Mozambique Compact included text requiring policy, legal and regulatory reforms related to maintenance, as listed on Annex I - page 13 of the agreement. What were the effects on road maintenance of these requirements? [Assumption: Maintenance]							
Assumption: Maintenance	Annual road maintenance funds allocated (*R-29.1 MCC Common Indicator list*)	MZM	Annual budget allocated for the MCC-funded roads and the road network (2014-2021)	N/A	N/A	**Secondary Sources** • Review available secondary sources from ANE & Road Fund	• Information obtained from the secondary sources will be triangulated with information obtained from the key informant interviews
	Annual road maintenance budget spent (*R-30.1 MCC Common Indicator list*)	MZM	Annual actual maintenance expenditures for the MCC-funded roads	N/A	N/A	**Secondary Sources** • Review available secondary sources from ANE and the Road Fund.	
	International Roughness Index (*R-9 MCC Common Indicator list*)	IRI (m/km)	IRI can be interpreted as the output of an idealized response-type measuring system, where the physical vehicle and instrumentation are replaced with a mathematical model [ASTM E1926 - 08(2021)]	3. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 IRI_{avg} = 3.9 m/km 4. Final Detailed Engineering Design Report – Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 5. IRI = 3.5 – 3.9 m/km	Rio Ligonha to Nampula Road: IRI_{avg} = 2.6 m/km Namialo – Rio Lurio road IRI_{avg} = 3.3 m/km	**Road Condition study and Road Roughness study** Use data collection under Evaluation Question 1	Use data collection under Evaluation Question 1
	Road Conditions Study	Cracking Percentage	Area with wide cracking, area with all cracking, area potholed, mean rut depth etc.	3. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to	Detailed road condition data is available	**Road Condition study** • Survey period: same time as road roughness study	Level of maintenance performed cross-checked with existing data on maintenance performed

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
	(percentage of pavement surface cracked)			Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 4. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 Detailed road condition data provided in the report.		• Equipment: The Road/Pavement Engineer will conduct a visual inspection of distress areas that were identified during the road roughness survey Interval: select sections identified during the road roughness survey	
Evaluation Question 2C: Are there factors influencing road transport agencies' maintenance policies and practices that could have been addressed by MCC to improve investment outcomes? What are these factors, and how should they be assessed during project design? [Assumption: Maintenance]							
Assumption: Maintenance	Annual road maintenance funds allocated (*R-29.1 MCC Common Indicator list*)	MZM	Annual budget allocated for the MCC-funded roads and the road network (2014-2022)	N/A	N/A	**Secondary Sources** Review available secondary sources from ANE & Road Fund	Information obtained from the secondary sources will be triangulated with information obtained from the key informant interviews
	Annual road maintenance budget spent (*R-30.1 MCC Common Indicator list*)	MZM	Annual actual maintenance expenditures for the MCC-funded roads and the road network (2014-2022)	N/A	N/A	**Secondary Sources** Review available secondary sources from ANE & Road Fund	
	International Roughness Index (*R-9 MCC Common Indicator list*)	IRI (m/km)	IRI can be interpreted as the output of an idealized response-type measuring system, where the physical vehicle and instrumentation are replaced with a mathematical model [ASTM E1926 - 08(2021)]	6. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 IRI_{avg} = 3.9 m/km 7. Final Detailed Engineering Design Report – Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011 IRI = 3.5 – 3.9 m/km	Rio Ligonha to Nampula Road: IRI_{avg} = 2.6 m/km Namialo – Rio Lurio road IRI_{avg} = 3.3 m/km	**Road Condition study and Road Roughness study** Use data collection under Evaluation Question 1	
	Road Conditions Study (percentage of pavement surface cracked)	Cracking Percentage	Area with wide cracking, area with all cracking, area potholed, mean rut depth etc.	5. Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010 6. Final Detailed Engineering Design Report –Revision 1: Volume 2: Main report – Part A: Roadworks, Scott Wilson Ltd., Feb 2011	Detailed road condition data is available	**Road Condition study** • Survey period: same time as road roughness study • Equipment: The Road/Pavement Engineer will conduct a visual inspection of distress areas that were identified during the road roughness survey Interval: select sections identified during the road roughness survey	Level of maintenance performed cross-checked with existing data on maintenance performed

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
				Detailed road condition data provided in the report.			
Evaluation Question 3A: Who is traveling on the road, why, what are they transporting, what are they paying for transport, and how long does it take to move along key routes? and Evaluation Question 3B: Have road usage patterns changed, in terms of who is travelling on the road, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes?							
Outcome: Reduced transportation costs & **Outcome:** Diverted and Generated/Induced Traffic	Average Annual Daily Traffic (to number and type of vehicle) (*R-10 MCC Common Indicator list*)	Number	Type of vehicles and number/frequency per day	• See description under Evaluation Question 1	• See description under Evaluation Question 1	**Use IMC counts of 2019 and Partial New Manual Traffic Count survey** See description under Evaluation Question 1	• See description under Evaluation Question 1
	Average Daily Road Users (*R-16 MCC Common Indicator list*)	Number	Number of passengers and drivers	• See description under Evaluation Question 1	• See description under Evaluation Question 1	**Origin-Destination survey** See description under Evaluation Question 1	• See description under Evaluation Question 1
	Trip Purpose (Business, Leisure and other) (*R-19 and R-20 MCC Common Indicator list*)	Percentage	Reported trip purpose of road users on the MCC roads (2022)	N/A	N/A	**Origin-Destination survey** • See description under Evaluation Question 1	• See description under Evaluation Question 1
		Percentage	Reported trip purpose of public transport users on the MCC roads (2022)	N/A	N/A	**Public Transport User Survey** • Conducted in combination with O-D survey or standalone, with passengers on small (<20) and large (>20) buses	• Back-translation and pre-test of questionnaire -Pilot test conducted • Data collected on electronic devices, if possible, to minimize data entry errors • Call-back of 10% respondents to verify collected data. - Triangulation against secondary sources - Ministry of Transport and Communication reports and administrative data on public transport.
	Transport fares (*R-25 MCC Common Indicator list*)	MZM	Fees for goods transported on MCC roads (2022)	N/A	N/A	**Origin-Destination survey**	• Refer to the section above under Evaluation Question 1
			Fares for passengers transported on the MCC roads (2022)	N/A	N/A	**KII with regulators** **PTU survey**	• Information from the KIIs and PTU surveys will be compared with secondary sources - Ministry of Transport and Communication reports and administrative data on public transport.
	Cargo Value (*R-21 MCC Common Indicator list*)	MZM	Type, volume, and value of goods transported by road users on the MCC roads (2022)	N/A	N/A	**Origin-Destination survey**	• Refer to the section above under Evaluation Question 1
	Cargo Weight (*R-22 MCC Common Indicator list*)	Kilograms	Type, volume, and value of goods transported by road users on the MCC roads (2022)	N/A	N/A	**PTU survey** • Please refer to the description above	• Back-translation and pre-test of questionnaire -Pilot test conducted

Program Logic Result	Indicator	Unit	Definition	Baseline Value & Source	Closeout Value & Source	Post-Compact: Proposed New Data Source	Data Quality Controls
							• Data collected on electronic devices, if possible, to minimize data entry errors • Call-back of 10% respondents to verify collected data. - Triangulation against secondary sources - Ministry of Transport and Communication reports and administrative data on public transport.
	Travel Time (*R-17 MCC Common Indicator list*)	Minutes	Travel time between origin and destination on the MCC roads (2022)	N/A	N/A	**Origin-Destination survey** • See description under Evaluation Question 1	• Refer to the section above under Evaluation Question 1
						Travel Time study • A test vehicle will be dispatched to travel along the project corridor during peak and lean traffic periods • Travel times will be recorded at designated intervals and checkpoints • Instrument: paper forms • Survey days: TBD after MTC data collection is analyzed to identify peak and lean traffic periods Survey period: July 2022	• All data collection rounds will be recorded and the data in the paper forms will be cross-checked against the recordings • Double entry of data collected to ensure accurate data entry Data entry using a software with built-in quality checks
Evaluation Question 4: Given the existing transportation market structure, what portion of VOC savings will be passed on to consumers of transportation services? If not all savings are passed on, how could this project have cost effectively addressed these inefficiencies? [Result: Reduced Transportation Costs]							
Outcome: Reduced transportation costs & **Assumption**: Competitive Transport Sector	Cost of Transportation (*R-23 MCC Common Indicator list*)	Percentage	Estimated vehicle operating cost savings that are passed on to transport consumers (if any) over the total estimated vehicle operating cost savings	N/A	N/A	**Key Informant Interviews** • Public transportation service providers and associations • Goods transporters operators and associations • ANE, Provincial Directorate of Transport and Communication; provincial governments, municipalities	• Back-translation of questionnaire • Information obtained from the KIIs will be triangulated with information obtained from the secondary sources: MCC Project Documents, ANE Documents, Road Fund Documents, historical records of transportation prices.
		Percentage		N/A	N/A	**Origin-Destination survey** • See description under Evaluation Question 1	• Refer to the section above under Evaluation Question 1
				N/A	N/A	**PTU** • See description under Evaluation Question 3A	• Refer to the section above under Evaluation Question 3A
						Secondary Sources • Review historical records of transportation prices	• Information obtained from the secondary sources will be triangulated with information obtained from the key informant interviews

IV. EVALUATION QUESTION 0

0) Was the project implemented according to plan? [Result: Road Rehabilitation]

IV.1 METHODOLOGY

IV.1.1 General Overview of Methodology

EQ 0 will be an ex-post performance evaluation looking at how the MCC Compact was designed and whether and how the implementation of the RRP deviated from the original design. It will be based on desk review and key informant interviews (KIIs)

The information obtained will also provide the team with a clear foundation to assess other evaluation areas. Based on the information gathered, the team will provide recommendations as relevant to inform future Compact designs.

IV.1.2 Detailed Methodology

EQ 0 will employ a mixed-methods approach to answer the evaluation question. Information will be drawn from secondary sources mainly using MCC and MCA project documents (e.g. design reports, as-built drawings, end of Compact review, monthly progress reports, etc.) for the Compact. In addition, information from secondary sources will be verified and complemented with KIIs with ANE and the Road Fund.

IV.2 TIMEFRAME OF EXPOSURE

The road improvements on the Namialo-Rio Lurio and Nampula-Rio Ligonha roads were not completed before the Compact ended. However, it is expected that the relevant results for EQ 0 were achieved.

IV.3 PRIMARY DATA COLLECTION – KIIS

IV.3.1 Sample Units

The stakeholder groups to be interviewed are MCC as well as ANE and Road Fund staff.

IV.3.2 Sample Size and Associated Assumptions

For all stakeholder categories except for transport users, IMC only conducted one KII three years ago. In the intervening three years, necessary updates concerning costs/prices pertaining to ANE, the Road Fund, and transportation and trucking companies will be necessary. Furthermore, the quantitative data collected by IMC for the O-D survey had reliability and validity issues and there is concern the qualitative data will be the same. For these reasons, IDG will conduct a second round to double check and validate the findings. Prior to the scheduling of interviews, the evaluation team will share the list of proposed subjects with MCC for validation and to ensure there is no redundancy.

At least three (3) interviews will be conducted, one with a representative of ANE, one with a representative of the Road Fund and one with an MCC representative.

IV.3.3 Sample Frame

Relevant ANE and Road Fund staff have been identified by the evaluation team. Relevant MCC staff member(s) will be identified with assistance from the MCC Evaluation Project Monitor and the IDG In-Country Coordinator.

IV.3.4 Sampling Strategy

Given the small number of interviews, a sampling strategy is not necessary. The team will seek guidance from MCC on whom to speak with, given the time lapse since project completion. Selection will be based on those who have the most relevant experience and information about the MCC Compact implementation.

IV.3.5 Instruments

Paper-form questionnaires.

IV.3.6 Rounds, Locations, and Timing

The KIIs will be conducted in July 2022.

IV.3.7 Respondent(s) within the Sample Unit

N/A

IV.3.8 Staff

The Evaluation Expert will conduct the KIIs in English, assisted by the In-Country Coordinator.

Data Processing

Given travel restrictions due to the COVID-19 pandemic, all KIIs will be conducted remotely via the Zoom platform and all meetings will be recorded and transcribed by the In-Country Coordinator. The evaluation team will also use the information available in the KIIs conducted by the previous evaluator IMC and ascertain whether the information is adequate to inform the overall content and methodology of IDG's EDR. The evaluation team will classify, sort, and arrange information gathered to identify trends and examine the relationships in the data using Taguette.

IV.3.9 Data Quality

While the Evaluation Expert leads the interviews and takes notes, the In-Country Coordinator/Junior Analyst will assist the interviews by taking notes that will be used to cross-reference with notes taken by the Evaluation Expert. The transcript will be reviewed by the Evaluation Expert within 24 hours of the interview. The team will cross-examine information when relevant to help build a body of evidence to support the analysis.

IV.3.10Safety Procedures/Precautions

N/A

IV.4 SUMMARY TABLE

Table 4 Primary Data Collection Summary Table for Evaluation Question 0

Data collection	Timing	Sample Unit/ Respondent	Sample Size	Relevant Instruments	Exposure Period
KIIs	July 2022	ANE/MCC/Road Fund	≥3	Paper questionnaire	8.5 years

IV.5 SECONDARY QUANTITATIVE DATA

IV.5.1 List of Secondary Data Sources

The team has conducted a preliminary review of the design documents provided by MCC and ANE. During the evaluation, any deviations from the initial Compact design will be noted and discrepancies between available information sources will be highlighted.

IV.5.2 Requirements for Data Capture

Data will be transferred electronically.

IV.6 ANALYSIS PLAN

Based on the secondary and qualitative data collected (KIIs), the team will evaluate how the RRP was implemented, the changes made during implementation and the reasons for the changes. The team will also review the rationale for the initial project design and assess whether the changes made during implementation were well-supported with evidence.

IV.7 CHALLENGES

IV.7.1 Limitations of Interpretation of the Results

The evaluation team will ask retrospective questions during the KIIs to gather information about the decision-making process that took place during the Compact implementation and how the implementation diverted from the original project design. Recall bias may impact the quality of information from the KIIs. The team will be cognizant of the risk that project staff interviewed may be subject to biases that could color their perspectives or influence the information they provide, given that they were involved in implementation.

Additional limitations are whether the evaluation team has accurate contact information for those who worked on the project, as well as whether former MCA-M staff are available to take part in interviews. MCC will initiate these requests on behalf of the evaluation team.

IV.7.2 Risks to the Study Design

Based on preliminary interviews with ANE and the RF to guide development of the present EDR, and documentation made available to date, the risks related to data collection are low.

A possible risk to answering this question is that some project implementation documents may not be available due to loss of records, or unwillingness of the stakeholders to share sensitive information.

V. EVALUATION QUESTION 1

1) Did the project reduce transportation costs? Was the magnitude of this reduction the same as was expected in the MCC investment decision CBA for the same exposure period? Why or why not? Was the MCC investment to achieve this reduction cost-effective (defined as exceeding MCC's 10% economic rate of return hurdle rate)? Is the current Economic Rate of Return (ERR) for the project different than the investment-decision ERR? If so, why? How could the project have been designed to result in a higher ERR? [Result: Reduced Transportation Costs]

V.1 METHODOLOGY

V.1.1 General Overview of Methodology

EQ 1 requires estimation of road agency and road user cost savings and an economic analysis, or a CBA, to calculate the economic rate of return of the road investment. The cash flow stream prepared at closeout indicates that the project investment will result in transport cost reduction of US$ 8.3 million in the case of the Namialo-Rio Lurio Road and US$ 7.6 million in the case of the Nampula - Rio Ligonha road in 2022. These estimated transport cost reductions consist of vehicle operating cost savings and time savings valued in monetary terms as a result of project road improvement under the MCC Compact. Determinants of transport cost savings are the improved road capacity and condition and the traffic growth. Evaluation will assess these aspects through primary surveys and estimate the transport cost savings to determine the magnitude of transport costs savings realized in comparison to transport cost savings expected during compact implementation. The purpose of determining economic return on the RRP is to assess whether the investment resulted in an acceptable rate of return in terms of quantifiable benefits (reduced transportation costs, improved safety and reduced maintenance costs) generated by the project. It also helps to compare the post-Compact rate with the pre-Compact ERR and assess the assumptions made for the investment decisions. EQ 1 will use the HDM-4 model, a CBA model specifically designed for road infrastructure to estimate transportations costs. It will compare the monetized benefits and costs for the "with Project" and "without Project" scenarios and calculate the road agency and road user transport costs and ERR.

V.1.2 Detailed Methodology

HDM-4 simulates two scenarios: 1) benefits and costs experienced from the project road if the RRP improvement did not take place (counterfactual), and 2) benefits and costs experienced from the project road with the RRP implementation. HDM-4 simulates the road condition and resources used for maintenance for each road section per year, as well as the vehicle speeds and physical resources consumed by vehicle operation (fuel, lubricants, etc.). After physical quantities involved in construction, road works, and vehicle operation are estimated, user-specified prices and unit costs are applied to determine financial and economic costs for road agency and road users in both scenarios. Relative benefits are then calculated for different alternatives for each component, followed by NPV and ERR computations. The model is then completed using a sensitivity analysis which will test how the ERR will change with adverse changes in assumptions of future traffic projects or maintenance.

The project's contribution to reduction in transportation costs (travel time and vehicle operating costs), maintenance costs, and improved safety are estimated (valued in monetary terms) over the analysis period. Economic performance of a project is appraised with NPV and the Internal Rate of Return (IRR) complemented by other derived ratios. The ERR, as calculated by the HDM-4 model, is the discount rate that equalizes the NPV to zero, where NPV is the discounted difference between the benefits accruing to road users generated by the implementation of the Project and the difference of Project costs as compared to the costs of the alternative "without Project." The magnitude of the expected ERR in the CBA is described in Section II.3.1 and II.3.2; the proposed methodology will be sufficient to measure a rate of return of 10% as required in the evaluation question.

V.2 TIMEFRAME OF EXPOSURE

Realization of impact and benefits of road construction projects depend on the extent of change and economic potential of the project impact area. There is no clear evidence to indicate when to collect data for HDM-4 after a road is completed. In general, "transport experts agree that it is unrealistic to expect to see immediate impacts on high-level outcomes, and that a few years are required for those changes to manifest."[58] While not in a developing country context, a study of 13 improved roads in England shows that the roads experienced an average of a seven percent increase in traffic, as compared to average background growth, between three to seven years after opening.[59] Based on this report and other relevant experience, the team believes that improving a congested road will bring out most of the impact within one to two years, whereas constructing a new road to areas without good access will take one to two years before starting to see early impacts, three to seven years to see larger impacts, and eight or more years to see the full impact.

The Road Rehabilitation in Mozambique was mostly completed by 2013. The MCC pre-compact ERR calculation assumed a 10% generated traffic after road rehabilitation apart from normal traffic growth. With data from the IMC study in 2019 or data collection as part of current evaluation in 2021, the exposure period will be over six years, which will have provided sufficient time to observe the anticipated effects.

V.3 PRIMARY DATA COLLECTION – MANUAL TRAFFIC COUNT

V.3.1 Sample Units

Motorized and non-motorized vehicles on the project road.

V.3.2 Sample Size and Associated Assumptions

All vehicles will be counted so sample size is not applicable.

V.3.3 Sample Frame

N/A

[58] MCC, Principles into Practice, Lessons from MCC's Investments in Roads, November 2017.
[59] Lynn Sloman, Lisa Hopkinson, and Ian Taylor, Campaign to Protect Rural England, The Impact of Road Projects in England, March 2017.

V.3.4 Sampling Strategy

V.3.5 Instruments

An A4 or letter size sheet of paper with space for four 15-minute intervals will be used for data collection such that each sheet represents one hour of vehicle movements. Vehicles will be recorded in batches of five using the '5-bar gate' configuration. At the end of the work shift, completed sheets will be transferred to the supervisor for control and data quality. The evaluation team will review local norms and standards when drafting the instrument and methodology to ensure data collection is conducted accordingly. The evaluation team will use the same classification as adopted by ANE and in the MCC project feasibility studies for counting as listed below.[60]

Vehicle Class	Vehicle Type	Vehicle Category	Description
A	Light	Car/SUV	Light vehicles used for passenger transport
B	Light	Pick-Up	Light goods vehicles commonly known as "pick-up" trucks
C	Light	Mini- Bus	Light passenger vehicles with a capacity of less than 20 persons
D	Heavy	Bus	Heavy passenger vehicles (20 or more passengers)
E	Heavy	Truck - Two axle	Heavy goods vehicles with double wheels on the rear axle
F	Heavy	Truck – 3&4 axle	Heavy goods vehicles with 3- 4 axles twin wheels on rear axle
G	Heavy	Truck – 5+ axle	Heavy goods vehicles with more than 4 axles
H	Heavy	Tractor	Agricultural tractors with or without trailer
I	-	Motor Cycle	Motorized Two-wheeler
J	-	Bicycle	Non-motorized bicycles

V.3.6 Rounds, Locations, and Timing

ANE conducts annual traffic counts on both roads at three stations each for a duration of one day, three times a year, and derives AADT for road sections applying seasonal correction factors derived from 10 main count stations in the country where one-week counts are done every month. MCC feasibility study consultants carried out traffic counts on the two project roads at four locations each in 2009 with a duration of one week. The count locations for ANE and MCC's feasibility study were not the same but covered the same sections.[61] IMC Worldwide also carried out traffic counts for a duration of three days each in December 2019 at the same locations used by the MCC feasibility study consultants.

[60] Government of Mozambique, ANE Planning Directorate, "Road Traffic Report 2019", April 2020

[61] For Nampula-Rio Ligonha Road ANE locations are at 15, 27 and 87 km from Rio Ligonha whereas feasibility study counts by SMEC was at 0.0, 27.4, 66.3 and 98.6 km from Rio Ligonha.

The 2019 IMC traffic count data can be adopted as basis for the evaluation considering the growth observed between 2009 feasibility study traffic and 2019 count traffic. However, a comparison with ANE traffic data shows a large difference in the case of Nampula-Rio Ligonha Road. There is also less clarity on the traffic level in the urban section close to Nampula and Namialo.[62] Therefore, it is proposed to conduct traffic counts on Nampula-Rio Ligonha Road and first section of Namialo-Rio Lurio Road where significant difference observed between 2019 counts reported by IMC and ANE counts. It is proposed to conduct the new counts at the same location as carried out for the feasibility study. During the field assessment, if any sub-section indicates largely different traffic than the count station traffic, it is also recommended to conduct a one day count at such sub-sections to evaluate developments since the project implementation. For new traffic counts, one round of manual traffic count (MTC) will be conducted. For seasonal variations of traffic patterns, the evaluation team will use ANE's seasonable adjustment factor established for Nampula province.

The duration of the MTC will be three (3) days including two (2) weekdays and one (1) weekend day, with each survey period lasting for 24 hours. The justification for doing a three (3) day MTC is that it allows for a balance between cost and representative data. Traffic counts are either done as one, three, or seven days. A three-day count will result in a good representation of weekly traffic by counting two weekdays and one weekend day and can be completed at a lower cost than that of a seven day count. The locations will be proposed by ANE or based on that of the feasibility study count or a location that best represents the section traffic based on the field reconnaissance. The preliminary traffic analysis sections to be considered are given below:

Nampula-Rio Ligonha Road	Namialo-Rio Lurio Road
1. Rio Ligonha – Murrupula 2. Murrupula – Namaita 3. Namaita – Outside Nampula 4. Nampula urban section	1. Namialo Urban section

In addition to traffic counts listed above at the same locations of pre-compact survey locations, MTC of 12-hour duration is recommended if any sub-section with significantly different traffic pattern observed during field assessment. The traffic counts are designed to count the sectional traffic and avoid local traffic by locating the stations away from local towns. The exact traffic count station locations will be decided in discussions with MCC.

V.3.7 Respondents within the Sample Unit

N/A

V.3.8 Staff

The evaluation team intends to subcontract the traffic count and the team sizes will be determined by the successful bidder based on a competitive procurement process. The evaluation team will allow bidders to consider conducting the traffic counts with teams of five enumerators (two for

[62] The SMEC feasibility study indicate a traffic of more than 10,000 between Km 96 and Km 102 in 2009/2010 whereas IMC count indicate less than 2000 vehicles and ANE estimate (for sections without a count station, ANE provides an estimate) indicate 3400 vehicles.

each direction and one enumerator to support both directions) taking six- or eight-hour shifts to be cost effective. One supervisor will be responsible for each team of enumerators.

V.3.9 Data Processing

Data will be entered using a double entry method, where the data entry operators will enter the data twice to identify mismatches. The mismatches will be corrected based on the original copy of the MTC form. All raw data collected will be entered using data entry software with built-in quality checks for data entry.

V.3.10 Data Quality

Quality Assurance/Quality Control (QA/QC) measures will be applied to ensure high quality data collection. The evaluation team will ensure data quality of traffic count forms filled in by counters. Prior to data collection, the subcontractor and the evaluation team will train and pilot the survey to ensure high quality data collection. During data collection, the evaluation team will conduct random checks to ensure the data are recorded correctly and quickly rectify any anomalies. Supervisors will monitor the data collection closely and ensure the vehicle types are properly categorized in the appropriate columns on the traffic count form. Traffic count stations will have a minimum of two personnel at all times and reserves will be in place in case of unexpected emergencies.

The data will be used to estimate AADT for each station. The procedure includes three steps, as described below:

i) Conversion of daytime counts to full day traffic (denominated Average Daily Traffic, ADT) on the basis of the percentage between daytime and full day counts carried out for one weekday and one for weekend day. This step is not necessary if the survey is conducted for 24 hours each day.
ii) Calculation of the weekly average ADT based on the daily ADT obtained in previous step and applying weekly correction factors established by ANE for less than one week counts.
iii) To obtain the AADT of the road, the season adjustment factor is applied to the average weekly ADT. The value of the season factor depends on the month of the year in which the counts have been made. The season factor provides the monthly fluctuation of traffic as compared to the year average. The seasonal correction factors established by ANE for Nampula province will be used.

V.3.11 Safety Procedures/Precautions

Approximately two to three meters of space is required inward from the carriageway in order to position tables, chairs, and also umbrellas or a tent-like structure for the counters that will provide protection against the sun and rain during data collection. Positioning of the survey location would also need to ensure good visibility in both directions (i.e. road bends or slopes must be avoided). In the evening or other dark times of the day, portable battery powered lamps with suitable back-up batteries will be placed for the counters. The surveyors will also be provided with yellow reflective jackets. Safety procedures will be in accordance with any guidance provided by ANE in charge of road control and safety. Additionally, appropriate COVID-19 measures will be followed for and by all the surveyors.

V.4 PRIMARY DATA COLLECTION – ORIGIN-DESTINATION SURVEY

Note:

The evaluation team proposes conducting a full O-D survey, even though IMC collected O-D data in 2019. The reasons are as follows:

- A partial O-D survey was conducted by IMC in 2019. The survey is considered "partial" in that it almost entirely excluded three key vehicle classes: passenger cars and vans/pickups (both in the class "simple light vehicles" as per ANE classification), and motorcycles. (The exception was 12 vehicles classified in the O-D dataset under "other", and described as "pessoal" or "caro peassoal" i.e. cars or personal cars). No explanation was given by IMC for the omissions of the vehicle classes. In addition, no PTU survey was conducted. In the SMEC 2019 traffic count, from 45% and 52% of all vehicles are cars and vans/pickups, so the missing vehicles represent a significant share of total vehicles.
- While IDG assesses the 2019 O-D data to be of satisfactory quality, the sample was much smaller than the planned 30%, at just 8-15%, depending on location. A large number of observations were discarded with minimal explanations as to why, and this raises concerns about possible bias in the final sample of 894.
- The alternative to conducting a full O-D survey would be to conduct an O-D survey targeting only the three classes of vehicles omitted from the 2019 O-D survey. IDG considers the likely results from this option not worth any potential savings. Combining 2019 O-D survey data (collected during the pre-COVID era) and new O-D survey data would involve assumptions and require additional data manipulation, introducing more uncertainty into the findings. Moreover, collecting data for all classes of vehicles, as opposed to just those omitted in 2019, is a marginal cost on top of the base cost of organizing and conducting the O-D survey.

V.4.1 Sample Units

The sample units are motorized vehicle drivers and passengers using the N1 Highway.

V.4.2 Sample Size and Associated Assumptions

The sample size will depend on the number of heavy vehicle drivers using the RMA Activity roads and the sampling rate. The sampling rate is determined based on traffic data for two groups: vehicles transporting goods, and passenger vehicles. In order to obtain statistically representative samples, their sample size will be adjusted to the respective peak hour traffic of the two vehicle groups. The adjustment to the peak hour is aimed at preventing traffic congestion caused by the axle load survey.

V.4.3 Sample Frame

The sample frame for the O-D survey is motorized vehicle drivers using the road sections where the interview stations are located. The vehicle categories in the sample frame are personal passenger cars, based on ANE light vehicle and heavy vehicle categories. Light vehicles are microbuses (<20 passengers), large buses (>20 passengers), trucks (all types), and tractors.

For passengers on buses, a separate PTU survey will be conducted, with enumerators either traveling on the bus and/or interviewing passengers at bus stations. This approach would be used avoid asking buses stopped for the O-D to wait, since they are normally on tight schedules and drivers would likely be willing to accommodate the survey team.

V.4.4 Sampling Strategy

Vehicle drivers for all vehicle types will be selected randomly based on the sampling rate for that vehicle. Sampling will be done in real time. A traffic counter will be placed at each interview station for each direction to count the traffic by vehicle type. The counter will indicate to the O-D interviewer and the police escort which vehicle will be intercepted for the interview based on the sampling rate. The counter will track the traffic volume by vehicle type, the number of attempted vehicle interceptions, the number of vehicles successfully intercepted, the number of interviewees interviewed, and those who did not provide consent.

The proposed O-D survey sample for each vehicle category will be calculated as illustrated in Table 5 for Traffic Count Station 2 at km 66.3 (30 km south of Nampula). The sampling rate is based on 10% margin of error and, 90% confidence interval, using the online software calculator Raosoft.com.

The exact number of vehicles which will be flagged down to be surveyed will depend on the traffic count at the O-D location, and on the practical concerns of counting. For example, it will be much easier for the survey team to flag every fourth van/pick-up truck than 2.7 out of 10 vans/pickup trucks. The overall sample size for each location will be approximately 26%.

Table 5 Sample size estimations by vehicle category

				Minimum sample size		
Category	**Share**	**N (2009)**	**Plus 10%***	**Raosoft calc.****	**Percentage**	**Out of every "x" vehicle**
Cars	27.8%	321	353	76	24%	Fourth
Vans-pickups	24.1%	278	306	74	27%	Fourth
Motorcycles	28.3%	326	359	36	11%	Fourth
Mini-buses	6.2%	72	79	44	61%	Second
Buses	1.6%	18	20	17	94%	(Every)
Trucks (2-axle)	4.4%	51	56	34	67%	Second
Trucks (3&4, 5+axle)	7.4%	85	94	48	56%	Second
Ag tractor	0.2%	2	2	2	100%	(Every)
Total	100%	1151	1266	331	26%	

* Increase sample size by 10% to take into account refusals/non-responses
** with 10% margin of error and, 90% confidence interval, 50% response distribution, based on http://www.raosoft.com/samplesize.html sample size calculator.

For the PTU survey, the team will for a sample size of 200 passengers, traveling on both mini-buses and regular buses. The survey would aim to randomly select 5-10 passengers per bus, and thus administer the survey on 20 to 40 buses, or 5 to 10 at each O-D location.

V.4.5 Instruments

The O-D survey will be conducted following a structured questionnaire. Two versions of the questionnaire will be used, one for vehicles transporting goods and the other for passenger vehicles. The questionnaire for vehicles transporting goods will include questions on the goods transported in addition to questions about their origin and destination. The questionnaire for passenger vehicles will include a section on fares in addition to questions on their origin and destination.

When releasing the Request for Proposal to select a data collection firm, the evaluation team will request that all bidders consider using electronic hand-held devices for data collection. The instrument/equipment used may depend on the availability of data collection firms in Mozambique with the required competency.

V.4.6 Rounds, Locations, and Timing

The O-D survey will be conducted one time over two (2) consecutive days of 24 hours which will, as far as possible, be representative days of the week (based on the AADT for the location).

- Locations: A total of four (4) O-D stations, as specified below, are planned for each road segment on the N1. The locations will be matched with existing ANE traffic count stations. Proposed locations, subject to review, are as follows: Namialo-Rio Lurio Road segment
    - Traffic Count Station 2 at km 5.0 (north of Namialo)
    - Traffic Count Station 5 at km 142.0 (south of Namapa)
- Nampula-Rio Ligonha Road segment
    - Traffic Count Station 1 at km 97.7 (just south of Nampula) *or* Traffic Count Station 2 at km 66.3 (30 km south of Nampula)
    - Traffic Count Station 4 at km 0.0 (at Rio Ligonha)

A map of the survey locations is available in Annex III. The selection of the locations is designed to capture traffic at the beginning and the end of the road sections but avoid urban traffic (Nampula). The placement of the four O-D stations, near the end of each of the two road segments, would capture nearly all traffic using the MCC roads. The average of the two values taken from traffic counts at the extremes of a given road segment is assumed to be the traffic volume of that section of the road. This is based on the underlying assumption that the route from one point to the other is linear.

The IDG team is proposing data collection for July 2022. The rationale for this timing is based on the following factors:

- COVID-19: Delaying data collection activities by a year will reduce risks to the team and data collection personnel safety, ensure the data obtained are of usable quality, and give significant weight to public health/ethical considerations. These considerations are informed by the following developments:

  - As of July 2021, case levels in Mozambique are trending sharply upward, indicative of a potential third wave of infection, that may last until the end of the current dry season. The third wave is projected to be the most severe outbreak yet.[63]
  - Vaccination rollout is slow; as of early July 2021 only 0.5% of the population had been vaccinated.[64]
  - As of July 2021, the government is still enforcing partial lockdowns which include work-from-home mandates, capacity limitations, and curfews in some areas. These measures restrict the free and regular movement of people and may skew survey results.[65]

- Seasonal weather: Considerations surrounding this factor entail ensuring team safety and ensuring the data obtained are of usable quality. These considerations are informed by the following:
  - Rainy season (November-April) in Nampula is among the most severe of all provinces in Mozambique.[66] Decreased visibility for drivers and hazardous road conditions due to rain would pose safety risks to the data collection team.
  - The roads may be less travelled during the rainy season due to safety concerns. Therefore, to obtain an accurate picture of road usage, postponing data collection until the following dry season is encouraged.
- Harvest and traffic
  - The province of Nampula has high levels of agricultural activity and the Nampula-Rio Ligonha road segment is part of a major agricultural trade route between Nampula and neighboring Zambezia province. Postponing the O-D survey until harvest season will allow the team to capture data on more traffic and commercial road users.

Data can be adjusted statistically to account for decreased traffic due to COVID-19 or seasonal factor. However, the more adjustments made to the data, the weaker the conclusions that can be drawn from the analysis. Based on these considerations, IDG proposes the timeframe of July 2022 for this data collection.

Based on these considerations, IDG proposes a timeframe of July 2022 for conducting O-D data collection activities.

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[63] "Mozambique; WHO Coronavirus Disease (COVID-19) Dashboard With Vaccination Data." World Health Organization, July 13, 2021. https://covid19.who/int/region/afro/country/mz.

[64] Ritchie, Hannah, Esteban Ortiz-Ospina, Diana Beltekian, Edouard Mathieu, Joe Hasell, Bobbie Macdonald, Charlie Giattino, Cameron Appel, Lucas Rodes-Guirao, and Max Roser. "Coronavirus (Covid-19) VACCINATIONS – Statistics and Research." Our World in Data, March 5 2020. https://ourworldindata.org/covid-vaccinations?country=MOZ

[65] Bhatia Gurman, Prasanta Kumar Dutta, and John McClure. "Mozambique the Latest Coronavirus Counts Charts and Maps." Reuters. Thomson Reuters, July 22, 2021. https://graphic.reuters.com/world-coronavirus-tracker-and-maps/countries-and-territories/mozambique/.

[66] Climate Knowledge Portal: Mozambique. World Bank. Accessed July 11th, https://climateknowledgeportal.worldbank.org/country/mozambique-data-historical

V.4.7 Respondents within the Sample Unit

The target respondent of the O-D survey is the driver of a motorized vehicle and selected passengers of the vehicle, with different modules for drivers and passenger origin and destinations. The evaluation team has selected this sampling strategy because the probability of passengers in the same vehicle (except for taxis) having different origins and destinations is generally low.

For the vehicles that have more than two passengers, the evaluation team may interview a maximum of three passengers – all selected randomly – noting that surveying more than two people will take additional time. Alternatively, the driver may be asked whether all his/her passengers have the same origin/destination, in which case passengers would not be interviewed individually. A decision on whether or not to interview passengers when they share the same origin/destination with the driver will be made after the O-D survey is piloted, during which time both approaches will be tested.

V.4.8 Staff

The evaluation team intends to subcontract the O-D survey. The team sizes will be determined by the successful bidder based on a competitive procurement process. All staff shall have proven experience in conducting O-D surveys or similar type of surveys. The data collection firm shall provide documentation supporting the required experience of its proposed staff. The evaluation team will allow bidders to consider conducting the O-D survey with teams of six (6) interviewers at each location taking six to eight-hour shifts to be cost effective. A supervisor will oversee each team.

V.4.9 Data Processing

If the evaluation successfully contracts a firm to use an electronic surveying method, hand-held electronic devices, such as tablets or smartphones, will be used to collect data. Survey software, such as SuveyToGo, SurveyCTO, or Open Data Kit, will be used depending on the capacity of the local data collection firm. Data will be uploaded from electronic devices and reviewed in real-time.

V.4.10 Data Quality

The first layer of quality assurance will be to ensure that the questionnaire is well-designed. Instruments drafted in English will be translated and then back translated to ensure the accuracy of the questions. The questionnaire will be pre-tested and piloted.

The second layer of quality assurance addresses the selection of interviewers with proven experience in O-D surveys or similar type of surveys. The interviewers will also be trained in asking questions in a way that drivers clearly understand and do not feel uncomfortable answering. Other quality assurance measures will include the design of questionnaires that are tailored to the traffic volume of the roads.

The third layer of quality control will be in the form of cross-checks to control the validity of answers. The survey process will be monitored by the supervisors to ensure reliable data are obtained. Supervisors will receive the completed questionnaires after the end of each work shift. The evaluation team will also conduct random spot checks to validate the data collection procedure. The evaluation team will also call back 10% of randomly selected respondents to ensure the data is recorded correctly.

V.4.11 Safety Procedures/Precautions

Safety measures including direct and continuous assistance by road police are critical for the safety of data collection staff. All personnel will be required to wear high-visibility safety vests at all times.

The evaluation team will develop traffic control plans with the data collection team in accordance with the guidelines from the local police to ensure personnel are safe at each survey station. The traffic plans will provide guidance on the position of the traffic delineators and the percentage of the road that needs to be cordoned off with traffic cones to allow for sufficient space to stop and park the vehicle while the surveyors are at work. The traffic plans will include sketches that provide a visual representation of the survey work area and the space to be reserved/cordoned off. The police, supported by appropriate signage, are expected to assist in intercepting vehicles and directing the surveyed vehicle to the secured survey area. In addition, approximately two to three meters of space will be required inward from the carriageway to position equipment (i.e. tables, chairs, umbrellas and/or tents) that will provide protection against the sun and rain and where surveyors can stow survey materials and/or rest during periods of inactivity.

COVID-19 measures: The consulting firm hired to conduct the survey will be responsible for ensuring that all data collection teams adhere to the strict measures agreed with IDG to reduce the risks of COVID-19 transmission, by requiring data collection team to wear appropriate personal protective equipment (PPE) (face masks, face shields, and gloves etc.) as agreed with IDG and to maintain a distance of two meters from the vehicle during interactions. The consulting firm will put in appropriate procedures to ensure that persons exhibiting symptoms are self-isolated at the lodging agreed. All personnel who were involved in data collection will be tested again if any persons exhibit symptoms.

V.5 PRIMARY DATA COLLECTION - VEHICLE OPERATING COST SURVEY

ANE's planning unit actively uses HDM-4 in their annual planning exercise and it is appropriate to use the vehicle operating input values used by ANE planning unit to adopt in the HDM-4 analysis. The input data was established by ANE in 2016. The evaluation team is yet to obtain the detailed data from ANE even though requests have been made to ANE multiple times after ANE confirmed HDM-4 is used in its planning exercise. HDM-4 level 1 calibration data is also available in HDM-4 calibration data prepared by IMC. A review of the input data from ANE and IMC will be undertaken and shall be used for the evaluation.

V.6 PRIMARY DATA COLLECTION – ROUGHNESS STUDY

V.6.1 Sample Units

Entire road length of the Namialo-Rio Lurio (149.67 km) and Nampula-Rio Ligonha (103 km) sections.

V.6.2 Sample Size and Associated Assumptions

Vehicular response to travelled surface is a continuous measure and sampling interval is not required. IRI will be calculated and reported for every 100m of both road sections. Therefore, a total of 29,940 IRI values will be reported for the Namialo-Rio Lurio section, or 14,970 for each

direction. For section Nampula-Rio Ligonha 20,600 IRI values will be reported, or 10,300 for each direction.

V.6.3 Sample Frame

GPS coordinates of the starting points and the ending points of both Namialo-Rio Lurio and Nampula-Rio Ligonha road sections are required to establish the starting and ending points of data collection for respective section.

V.6.4 Sampling Strategy

The entire Namialo-Rio Lurio and Nampula-Rio Ligonha road sections will be surveyed in both directions and IRI will be reported at 100m intervals.

V.6.5 Instruments

V.6.6 Rounds, Locations, and Timing

One round of roughness measurement will be collected in July 2022. The location of data collection will be on the Namialo-Rio Lurio and Nampula-Rio Ligonha road sections.

V.6.7 Respondents within the Sample Unit

N/A

V.6.8 Staff

The evaluation team intends to subcontract the IRI data collection. The team size will be determined by the successful bidder based on a competitive procurement process. The consulting firm may staff the data collection with two staff, one driver, and one technician for IRI. The topographic survey for the calibration will be performed by two or three survey teams of three or four persons.

V.6.9 Data Processing

The average of IRI values obtained using a topographical survey will be plotted against the laser roughness value (as the data collection firm will use a laser profiler) for each of the test sections. The calibration equation will be derived by calculating the best fit line for the points. The calibration equation can then be used to convert data from bump counts or laser profiler output into IRI units. The roads will then be sectioned into homogeneous sections which will also be illustrated in graphical format.

V.6.10 Data Quality

To ensure high-quality data collection, it is essential that the laser profiler is properly calibrated and regularly checked and that proper testing procedures are followed. Calibration of the roughness measuring equipment will adhere to manufacturer recommendations and follow the appropriate ASTM specifications as well as those mentioned in the World Bank Technical Paper No 46. The equipment will be calibrated on six (6) straight reference sections, 300m long each, which are representative of the IRI range expected on the Namialo-Rio Lurio and Nampula-Rio Ligonha road sections. Each reference section will have its longitudinal profile measured on two-wheel paths using a topographical survey and/or dipstick method (Class 1).

The same six test sections will be run five (5) times at least at two speeds within the standard range of vehicle speed on the road to test repeatability. The results will be used to establish a calibration equation (or calibration equations for different measuring speeds, as needed) for the laser profiler road roughness measuring device.

During data collection, a constant speed will be maintained within a certain range. The IDG evaluation team will closely monitor the data collection process and conduct random checks to ensure the data is collected correctly and quickly rectify for any anomalies.

V.6.11 Safety Procedures/Precautions

IRI is measured at a constant speed and does not require traffic to be diverted. Staff conducting the survey will remain in the vehicle at all times. Caution signs will be posted at the back of the vehicle or a rotating emergency light will be placed on the roof of the vehicle to indicate to other drivers that the survey is in progress and that the vehicle may be proceeding at a slower speed. For the topographical survey, all staff members will wear reflective vests and proper caution signs will be placed before and after the survey sections to warn drivers on the road. Additionally, appropriate COVID-19 measures will be followed for and by all the surveyors.

V.7 PRIMARY DATA COLLECTION – ROAD CONDITION STUDY

V.7.1 Sample Units

N/A

V.7.2 Sample Size and Associated Assumptions

N/A

V.7.3 Sample Frame

N/A

V.7.4 Sampling Strategy

N/A

V.7.5 Instruments

No detailed road condition study is anticipated. The road condition will be estimated based on visual assessment of the major surface distresses that will be performed during Road Roughness survey. The Roads/Pavement Engineer will also inspect the maintenances performed, potential cause of deterioration, and the location alongside the road. The Roads/Pavement Engineer will note the following distresses, surface texture, and drainage distresses during the Road Roughness survey:

- Cracking: structural (fatigue, wheel track cracking) and transverse (% area).
- Potholes (#/km): average number of potholes, which is defined as open cavity in the road surface with at least 150mm in diameter and at least 25mm depth.
- Rutting (mm): average rut depth.
- Edge break (m^2/km): distressed area within 0.5 m from the pavement edge.
- Raveling (% area): area with loss of material from wearing surface.

- Texture depth: qualitatively assessed in 3-level rating, as good, fair, and slippery, based on the HDM-4 default aggregate table for texture depth.
- Skid resistance: qualitatively assessed in 3-level rating, as good, fair, and slippery, based on the HDM-4 default aggregate table for skid resistance.
- Drainage condition: qualitatively assessed in 5-level ratings, as Excellent, Good, Fair, Poor or Very Poor, based on AASHTO Guide for Design of Pavement Structures[67] as a function of the permeability of subsurface materials, the crossfall and longitudinal gradients, the drainage distance and the type of drainage structure.

V.7.6 Rounds, Locations, and Timing

The visual inspection will be conducted in July 2022 as part of the Road Roughness study. Please see the note in section V.4.6 on this timing.

V.7.7 Respondents within the Sample Unit

N/A

V.7.8 Staff

The Road Condition visual inspection will be performed by the Roads/Pavement Engineer while monitoring the Road Roughness study.

V.7.9 Data Processing

Based on the visual inspection of the road distresses and maintenance performed, the Roads/Pavement Engineer will determine the road condition of both road sections following the guideline in classification and categorization of distresses of the HDM Documentation, Volume 4 – Analytical Framework and Model Description, Part C – Road Deterioration Models.

V.7.10 Data Quality

The road condition data will be reviewed by the Team Leader/Road Maintenance Expert and the HDM-4 Specialist to ensure that the Roads/Pavement Engineer's assessment of the road is appropriate and reasonable. Where appropriate, the Roads/Pavement Engineer will capture photos of distresses and maintenance works to support the determination of the road condition level.

V.7.11 Safety Procedures/Precautions

Staff conducting the survey will remain in the vehicle at all times. Caution signs will be posted at the back of the vehicle or a rotating emergency light will be placed on the roof of the vehicle to indicate to other drivers that the survey is in progress and that the vehicle may be proceeding at a slower speed. For the topographical survey, all staff members will wear reflective vests and proper caution signs will be placed before and after the survey sections to warn drivers on the road. Additionally, appropriate COVID-19 measures will be followed for and by all the surveyors.

[67] AASHTO Guide for Design of Pavement Structures, American Association of State Highway and Transportation Officials, Washington D.C., 1993.

V.8 PRIMARY DATA COLLECTION – PTU SURVEY

Data on value of time and purpose of trips using public transport from a PTU survey will be used to determine cost savings for public transport users along the MCC-funded roads. A separate data collection is not required to address EQ 1 because the evaluation team will conduct a PTU survey as part of EQ 3. More detail on this survey is in Section IX.5.

V.9 SUMMARY TABLE

Table 6: Primary Data Collection Summary Table for Evaluation Question 1

Data collection	Timing	Sample Unit/ Respondent	Sample Size	Relevant Instruments	Exposure Period
Traffic count	June/July 2022	Motorized and non-motorized vehicle on N1 road	N/A	Traffic count form	8.5 years
O-D survey	July 2022	Motorized and non-motorized vehicle on N1 road	The sample size will depend on the number of heavy vehicle drivers using the RMA Activity roads and the sampling rate. The sampling rate is determined based on traffic data for two groups: vehicles transporting goods, and passenger vehicles.	O-D survey questionnaire	8.5 years
VOC survey	Will use data from IMC and ANE	Determined by source	N/A	Determined by source	8.5 years
Roughness study	July 2022	Namialo-Rio Lurio (149.67 km) and Nampula-Rio Ligonha (103 km) roads	29,940 IRI values (Namialo – Rio Lurio) 20,600 IRI values (Nampula-Rio Ligonha)	Class 1 Laser profiler	8.5 years
Road Condition study (visual observation during roughness study)	July 2022	Namialo-Rio Lurio (149.67 km) and Nampula-Rio Ligonha (103 km) roads	N/A	Road Condition form	8.5 years

V.10 SECONDARY QUANTITATIVE DATA

V.10.1 List of Secondary Data Sources

IDG will obtain the following secondary data from ANE:

- Maintenance cost data for the MCC-financed roads and a sample of other similar roads that have been rehabilitated
- As-built drawings for the MCC-financed roads

- Deflection testing data from 2015 and more recent data, if available
- Periodic road condition reports
- Visual condition survey and material testing results, if available

V.10.2 Requirements for Data Capture

Maintenance cost data from ANE will be compared with international costs to verify the legitimacy of the data. If available in paper form, data will be input into Excel accordingly. If available in an electronic format, the documents will be transferred electronically from ANE.

All available as-built drawings will be reviewed for accuracy by verifying the information with QA/QC documents and team's observations of the road.

V.11 ANALYSIS PLAN

The HDM-4 analysis is used to estimate the economic or engineering viability of road investment projects by considering the following issues:

- Pavement surface and structural performance
- Life-cycle predictions of road deterioration, maintenance effects, and costs
- Road user costs and benefits
- Economic comparisons of project alternatives

The life-cycle analysis uses sets of costs incurred by the road administration and by the road user. The two sets of costs are added together over time in discounted present values. Costs are determined by first predicting physical quantities of resource consumption and then multiplying these quantities by their unit costs or prices. Economic benefits are then determined by comparing the total cost streams for various maintenance and construction alternatives with a base case (*do minimum* alternative), usually representing minimal routine maintenance.

The economic returns are mainly in the form of savings in road user costs due to the provision of a better road quality. The cost of construction, road maintenance, and road user costs constitute what is commonly referred to as the total (road) transport cost or the whole life cycle cost.

The remaining service life of pavement will be estimated using AASHTO 1993, "AASHTO Guide for Design of Pavement Structures" method. The effective structural capacity of a pavement, expressed as effective structural number (SN_{eff}) will be calculated based on:

- non-destructive deflection testing though direct evaluation of in situ subgrade and pavement stiffness along the project,
- visual condition survey and material testing, that involves assessment of current condition based on distress and drainage surveys, as well as some coring and testing of materials, or
- fatigue damage from traffic (if accurate historical traffic data and axle weights are available).

Deflection data provide the most accurate information on actual pavement structural capacity, while remaining life calculation based on historical traffic is most applicable for pavements which have very little visible deterioration. Once the effective structural capacity of the pavement is

known, it can be used to calculate the remaining pavement service life using the same new pavement design equations/ charts (please refer to Part III AASHTO Guide for Design of Pavement Structures, pages III-88 to III-105). Taking into account pavement age at time of deflection testing and condition survey, calibration coefficients for HDM-4 pavement deterioration models will be adjusted to reflect actual pavement remaining service life. The available deflection testing data from 2015 will be used for remaining life calculations and adjustments of pavement deterioration models.

For the current evaluation, a maintenance scenario will be developed based on the review of current practices in Mozambique and consultation, which will be used in the HDM-4 model for calculating the ERR. It could be a single likely maintenance scenario or multiple likely scenarios. For comparison with pre-Compact and close-out ERRs, it is recommended that the pre-Compact and close-out ERRs be recalculated with pre-Compact and close-out analysis assumptions and selected maintenance scenario for evaluation.

V.12 CHALLENGES

V.12.1 Limitations of Interpretation of the Results

CBA naturally requires the evaluation team to compare the "with-project' and "without-project" scenario of the road investment. It is a comparison between what actually happened after MCC's road investment and what would have happened in the absence of MCC investment. Therefore, the evaluation team will be making the best judgment on how the roads would have been if MCC had not invested in them in the first place by referring to several other sources and pre-Compact data. However, the results are limited because the "without-project" is not directly observable.

Furthermore, assumptions on future maintenance will be made based on review of maintenance regime in place in Mozambique and the trend in maintenance budget allocations. These assumptions may have a significant impact on the results.

V.12.2 Risks to the Study Design

The evaluation design maximizes the use of available data to be cost-effective in its data collection which poses some risk to the data quality and data availability. Nevertheless, the preliminary discussions the evaluation team has had with ANE and the Road Fund indicate their commitment to provide the available information in a timely manner, which will facilitate the team's ability to plan for its data collection accordingly.

VI. EVALUATION QUESTION 2A

2A) What are the relevant road authority's current maintenance practices? What is the likelihood that MCC's investment will remain adequately maintained for the life of the investment? Additionally, what maintenance regime (presented graphically, with time on the x axis and International Roughness Index (IRI) on the y axis) reflects current practices and will therefore be used in HDM-4? What maintenance practices most influenced your selection of this regime? Finally, there was some debate during compact re-scoping as to whether the counterfactual should include periodic maintenance or not. Which counterfactual is most likely, and what evidence do you have to support this choice? [Assumption: Maintenance]

VI.1 METHODOLOGY

VI.1.1 General Overview of Methodology -

EQ 2A will be an ex-post performance evaluation reviewing the current maintenance practices in Mozambique after the end of the Compact and their impact on the Nampula-Rio Ligonha and Namialo-Rio Lurio roads. Determining the maintenance regime will allow the evaluation team to estimate whether or not Nampula-Rio Ligonha and Namialo-Rio Lurio roads have been and will be adequately maintained by the GOM.

VI.1.2 Detailed Methodology

The evaluation team will determine the answers to EQ 2A through secondary sources to the extent possible, complemented by KIIs. Information will be drawn from secondary sources, mainly from ANE, as well as the Road Fund, to determine the prevailing maintenance practices. Most of the indicators presented in **Table 3** can be measured by reviewing secondary sources. KIIs will be used to verify secondary sources and complement findings. For instance, the team will ask questions on the decision-making process, such as the selection procedures and criteria for road maintenance and rehabilitation and the process for deciding the maintenance treatment that should be performed.

VI.2 TIMEFRAME OF EXPOSURE

As the Nampula-Rio Ligonha and Namialo-Rio Lurio roads were completed in 2013, the GOM has been conducting routine and emergency maintenance in the last seven years. The evaluation team will review the information from the past seven years to determine the maintenance practices. Periodic maintenance is usually required five or more years after improvement; therefore, the current evaluation should capture periodic maintenance decisions for Nampula-Rio Ligonha and Namialo-Rio Lurio roads.

VI.3 PRIMARY DATA COLLECTION - KIIS

VI.3.1 Sample Units

Key stakeholder organizations for road maintenance.

VI.3.2 Sample Size and Associated Assumptions

In total, around 8-9 interviews are expected to be completed. Key stakeholders to be interviewed include relevant officials from the 1) ANE; 2) ANE technical staff; 3) Road Fund; 4) road maintenance contractors; 5) relevant municipalities; 6) donors active in the road sector (e.g., World Bank). In consideration of stakeholders' time, IDG will first review available data from IMC, and the KIIs will only be conducted where necessary to corroborate or extend IMC's data, and kept to the briefest possible length needed for this purpose.

VI.3.3 Sample Frame

A list of key stakeholders from each organization will be drafted by the evaluation team prior to data collection.

VI.3.4 Sampling Strategy

Interviewees will be selected by the evaluation team based on their understanding of road maintenance practices and their involvement with the maintenance of the Nampula-Rio Ligonha and Namialo-Rio Lurio roads.

VI.3.5 Instruments

The team will conduct semi-structured interviews with a fairly open framework which allows for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data is collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries to obtain more specific information. Interviewees' responses will be transcribed on paper forms.

VI.3.6 Rounds, Locations, and Timing

The KIIs will be conducted in July 2022. The interviews for EQ 2A will be combined with the interviews for addressing EQ 2B and EQ 2C to maximize the information gathered, while optimizing resources. Remote interviews will cover stakeholders in Maputo and relevant villages/cities alongside the Nampula-Rio Ligonha and Namialo-Rio Lurio roads.

VI.3.7 Respondent(s) within the Sample Unit

Representatives from key stakeholder organizations for road maintenance.

VI.3.8 Staff

The Team Leader/Road Maintenance Expert will conduct the KIIs in English, assisted by the In-Country Coordinator.

VI.3.9 Data Processing

Given the travel restriction due to the COVID 19 pandemic, all KIIs will be conducted remotely via the Zoom platform and all meetings will be recorded and transcribed by the In-Country Coordinator. The evaluation team has also used the information available in the KIIs conducted by the previous evaluator, IMC, to inform the overall content and methodology of IDG's EDR. The evaluation team will classify, sort, and arrange information gathered to identify trends and examine the relationships in the data using Taguette.

VI.3.10 Data Quality

While the Team Leader/Road Maintenance Expert leads the interviews and takes notes, the In-Country Coordinator will assist the interviews by taking notes that will be used to cross-reference the notes taken by the Team Leader/Road Maintenance Expert. The notes will also capture non-verbal information (circumstances of the interview, emotions, body language, etc.). The transcript will be reviewed by the Team Leader/Road Maintenance Expert within 24 hours of the interview. The team will cross-examine information when relevant to help build a body of evidence to support the analysis.

VI.3.11 Safety Procedures/Precautions

All interviews will be conducted remotely.

VI.4 SUMMARY TABLE

Table 7 Primary Data Collection Summary Table for Evaluation Question 2A

Data collection	Timing	Sample Unit/ Respondent	Sample Size	Relevant Instruments	Exposure Period
KIIs	July 2022	Maintenance stakeholders	8-9	KII questionnaire	8.5 years

VI.5 SECONDARY QUANTITATIVE DATA

VI.5.1 List of Secondary Data Sources

The evaluation team will collect secondary data from various sources to address EQ 2A. The team will request documents from the ANE, road maintenance firms, and the Road Fund. The team will also consider secondary sources of data collected during IMC's Evaluation. The evaluation will attempt to obtain the following documents as available:

- Current laws, regulations, decrees on road maintenance
- Road maintenance policies and processes from 2011 to present
- Records of road maintenance budget estimated, budget allocated, and budget spent from 2014 to present
- Number of periodic maintenances completed on comparable and older roads

Upon collecting the secondary sources, the team will examine the current road maintenance practices. This will allow the team to evaluate whether GOM's institutional, financial, and technical aspects of the road maintenance sector are adequate in comparison to international standards. The allocated maintenance budgets and the actual expenditures will be reviewed to estimate whether adequate funds have been allotted and used for the routine, emergency, and periodic maintenance.

Road roughness and road condition studies will be conducted to assess riding quality and the physical distress on the MCC funded roads. A separate data collection is not required to address EQ 2A because the evaluation team will conduct the IRI study and a visual inspection of the road (road condition) as part of EQ 1.

VI.5.2 Requirements for Data Capture

The majority of secondary sources will be government documents that will most likely be in Portuguese. The Team Leader is a native Portuguese speaker. He will review the documents and, recommend the sections that should be professionally translated for the purpose of the evaluation. If secondary data are only available in paper form, data will be input into Excel accordingly. If available in an electronic format, the documents will be transferred electronically.

VI.6 ANALYSIS PLAN

Based on the secondary data collected and the qualitative data collected (KIIs), the team will evaluate the current road maintenance practices in Mozambique, the maintenance works performed on the MCC-funded roads, analyze the impact of road maintenance reforms, and determine the likelihood that MCC's investment on the roads will remain adequately maintained for the life of the investment. Based on this assessment, the team will update the maintenance assumptions used in the HDM-4 model.

The data collected will serve as inputs to determine the maintenance regime for the HDM-4 analysis through an informed discussion between the Team Leader/Road Maintenance Expert, the HDM-4 Specialist, and the Pavement Expert. Each indicator for EQ 2A will be obtained as follows:

- Annual maintenance budget estimated
    - Annual maintenance budget estimated for the MCC road sections will be determined by reviewing the budget requested from the ANE between 2014-2022.
    - Data gathered from secondary sources will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data.
- Annual maintenance budget allocated
    - Annual maintenance budget allocated for the MCC road sections will be determined by reviewing the budget requested from ANE's actual allocation between 2014-2022.
    - Data gathered from secondary sources will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data.
- Annual maintenance budget spent
    - Annual actual maintenance expenditure on the MCC road sections will be determined by reviewing ANE's expenditures between 2014-2022.
    - Data gathered from secondary data will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data.
- Likelihood of periodic maintenance taking place
    - Team Leader/Road Maintenance Expert will determine up to 3 comparable and older roads by consulting the ANE during the KIIs taking into consideration the following factors: 1) year when last rehabilitation was undertaken, 2) traffic usage in the last two-three years, and 3) road condition in the last two-three years. Upon selecting the comparable roads, the Team Leader/Road Maintenance Expert will determine whether periodic maintenance took place on these roads.
    - Information gathered from the KIIs will be verified using ANE's data on periodic maintenance performance.
- Quality of maintenance performed

  - Road roughness study and the road condition study (visual inspection) will be used to determine the current quality of emergency and routine maintenance performed on the MCC-funded road sections. Team Leader/Road Maintenance Expert will use the data to develop a descriptive analysis of the quality of maintenance performed on the MCC road sections.

- Road maintenance laws, policies, and processes
  - Team Leader/Road Maintenance Expert will review available secondary sources to identify the laws and policies that govern the maintenance of the MCC road sections. Any recently updated laws and decrees will be reviewed in closer detail to understand its potential impact on future road maintenance.
  - Key informants will be asked to describe the current laws, policies, and processes. Based on the KIIs, the information will be analyzed using qualitative data software to determine how these laws and regulations affect maintenance practices.

The Team Leader/Road Maintenance Expert will use the information gathered to determine the maintenance regime for the HDM-4 analysis, in discussion with the HDM-4 Specialist and the Pavement Expert.

VI.7 CHALLENGES

VI.7.1 Limitations of Interpretation of the Results

The interviews conducted by the team may be influenced by response bias. The stakeholders often have a strong incentive to hide their illicit activities, such as corruption or participating in informal economic ventures. Similarly, stakeholders may be biased to answer in a certain way for social or political incentives. Consequently, the team is likely to encounter difficulties in probing and understanding these issues, as well as ascertaining the true interests of the people engaged in such activities. Similarly, even if the purpose of the interviews is explained prior to the interviews, Mozambique government staff may want to show positive results from the Compact to justify further investments from MCC.

VI.7.2 Risks to the Study Design

Secondary data sources and KIIs will be essential for answering EQ 2A. There is a risk that these documents may not be available to the evaluation team due to a delay in locating the documents, loss of past records, or unwillingness of the stakeholders to share sensitive information. Even when the documents are available to the team, the documents may be an inaccurate representation of the actual practice.

An additional risk is gathering accurate information from KIIs that the evaluation team cannot corroborate with data and/or documents. Interviewees may have biases and/or incentives to skew the information they provide to the evaluation team. To minimize these risks, we will interview all relevant institutional stakeholders for road maintenance, as well as private sector representatives, in order to validate the information from multiple perspectives. Furthermore, the road roughness study and the road condition study (visual inspection) will be an objective check of the appropriateness of the road maintenance standards being applied to the two MCC-financed roads.

VII. EVALUATION QUESTION 2B

2B) The Mozambique Compact included text requiring policy, legal and regulatory reforms related to maintenance, as listed on Annex I - page 13 of the agreement. What were the effects on road maintenance of these requirements? [Assumption: Maintenance]

VII.1 METHODOLOGY

VII.1.1 General Overview of Methodology

EQ 2B will be a pre-post performance evaluation to determine the effect of the requirements for periodic road maintenance in Mozambique. Data collection for EQ 2B will overlap with the data collection required for EQ 2A. Therefore, the KIIs designed to inform EQ 2A will serve also to inform the EQ 2B.

VII.1.2 Detailed Methodology

The evaluation team will determine the answers to EQ 2B through secondary sources to the extent possible, complemented by KIIs. Information will be drawn from secondary sources, mainly from ANE, to determine the effects of compact requirements for the GOM to conduct road maintenance on the overall road network. Most of the indicators presented in Table 3 can be measured by reviewing secondary sources. KIIs will be used to verify secondary sources and complement findings.

VII.2 TIMEFRAME OF EXPOSURE

As part of that investment, the GOM committed to conduct periodic road maintenance. Therefore, there should be sufficient evidence to determine whether the requirements were met, and the road fund was accurately funded but also whether the funds have been used for maintenance since 2014.

VII.3 PRIMARY DATA COLLECTION - KIIS

VII.3.1 Sample Units

Key stakeholder organizations for road maintenance.

VII.3.2 Sample Size and Associated Assumptions

In total, around 8-9 interviews are expected to be completed. Key stakeholders to be interviewed include relevant officials from the 1) ANE; 2) ANE technical staff; 3) Road Fund; 4) road maintenance contractors; 5) relevant municipalities; 6) donors active in the road sector (e.g., World Bank).

VII.3.3 Sample Frame

A list of key stakeholders from each organization will be drafted by the evaluation team prior to data collection.

VII.3.4 Sampling Strategy

Interviewees will be selected by the evaluation team based on their understanding of road maintenance practices and their involvement with the maintenance of the Nampula-Rio Ligonha and Namialo-Rio Lurio roads.

VII.3.5 Instruments

The team will conduct semi-structured interviews with a fairly open framework which allows for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data is collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries to obtain more specific information. Interviewee's responses will be transcribed on paper forms.

VII.3.6 Rounds, Locations, and Timing

The KIIs will be conducted in July 2022. The interviews for EQ 2A will be combined with the interviews for addressing EQ 2B and EQ 2C to maximize the information gathered and optimize resources. Remote interviews will include stakeholders based in Maputo and relevant villages/cities alongside the MCC funded roads. Please see the note in section V.4.6 on this timing.

VII.3.7 Respondent(s) within the Sample Unit

Representatives from key stakeholder organizations for road maintenance.

VII.3.8 Staff

The Team Leader/Road Maintenance Expert will conduct the KIIs in English, assisted by the In-Country Coordinator.

VII.3.9 Data Processing

Given the travel restriction due to the COVID 19 pandemic, all KIIs will be conducted remotely via the Zoom platform and all meetings will be recorded and transcribed by the In-Country Coordinator. The evaluation team will also use the information available in the KIIs conducted by the previous evaluator IMC and ascertain whether the information is adequate to inform the overall content and methodology of IDG's EDR. The evaluation team will classify, sort, and arrange information gathered to identify trends and examine the relationships in the data using Taguette.

VII.3.10 Data Quality

While the Team Leader/Road Maintenance Expert leads the interviews and takes notes, the In-Country Coordinator will assist the interviews by taking notes that will be used to cross-reference the notes taken by the Team Leader/Road Maintenance Expert. The notes will also capture non-verbal information (circumstances of the interview, emotions, body language, etc.). The transcript will be reviewed by the Team Leader/Road Maintenance Expert within 24 hours of the interview. The team will cross-examine information when relevant to help build a body of evidence to support the analysis.

VII.4 SUMMARY TABLE

Summary table of primary data collection is not included in this section because additional primary data collection is not required for EQ 2B.

VII.5 SECONDARY QUANTITATIVE DATA

VII.5.1 Limitations of Interpretation of the Results

The evaluation team will use secondary data collected under EQ 2A.

Upon collecting the secondary sources, the team will examine national road maintenance expenditure, maintenance expenditure related to the Roads, and the quality of maintenance performed. A separate data collection is not required to address EQ 2B because the evaluation team will conduct the IRI study and the Road Condition study as part of EQ 1.

VII.6 ANALYSIS PLAN

Based on the secondary data collected and the qualitative data collected (KIIs), the team will examine the effect of the compact requirements and their impact on the road maintenance. Each indicator for EQ 2B will be analyzed as follows:

- Annual maintenance budget allocated for road maintenance
    - Annual maintenance budget allocated for the road maintenance for the MCC-funded road and the road network (disaggregated by type of maintenance) will be determined by reviewing the budget allocated from ANE and the Road Fund (2014-2022).
    - Data gathered from secondary data will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data. If the budget allocated for road maintenance is low, the KIIs will be used to determine the factors that led to limited funding.
- Annual maintenance budget spent on road maintenance
    - Annual actual maintenance expenditure on the road maintenance for the MCC-funded road and the road network (disaggregated by type of maintenance) will be determined by reviewing the budget allocated from ANE and the Road Fund (2014-2022).
    - Data gathered from secondary data will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data.
- Quality of maintenance performed by ANE.
    - Road roughness study and the road condition study (visual inspection) will be used to determine the quality of emergency and routine maintenance performed on the MCC-funded roads.
    - Based on the KIIs and the above studies, the Team Leader/Road Maintenance Expert will determine the quality of maintenance performed.

VII.7 CHALLENGES

VII.7.1 Limitations of Interpretation of the Results

The interviews conducted by the team may be influenced by response bias. The stakeholders often have a strong incentive to hide their illicit activities, such as corruption or participating in informal economic ventures. Similarly, stakeholders may be biased to answer in a certain way for social or political incentives. Consequently, the team is likely to encounter difficulties in probing and

understanding these issues, as well as ascertaining the true interests of the people engaged in such activities. Similarly, even if the purpose of the interviews is explained prior to the interviews, government staff may want to show positive results from the Compact to justify further investments from MCC.

VII.7.2 Risks to the Study Design

Secondary data sources and KIIs will be essential for answering EQ 2A. There is a risk that these documents may not be available to the evaluation team due to a delay in locating the documents, loss of past records, or unwillingness of the stakeholders to share sensitive information. Even when the documents are available to the team, the documents may be an inaccurate representation of the actual practice.

An additional risk is gathering accurate information from KIIs that the evaluation team cannot corroborate with data and/or documents. Interviewees may have biases and/or incentives to skew the information they provide to the evaluation team. To minimize these risks, we will interview all relevant institutional stakeholders for road maintenance, as well as private sector representatives, in order to validate the information from multiple perspectives. Furthermore, the road roughness study and the road condition study (visual inspection) will be an objective check of the appropriateness of the road maintenance standards being applied to the two MCC-financed roads.

VIII. EVALUATION QUESTION 2C

2C) Are there factors influencing road transport agencies' maintenance policies and practices that could have been addressed by MCC to improve investment outcomes? What are these factors, and how should they be assessed during project design? [Assumption: Maintenance]

VIII.1 METHODOLOGY

VIII.1.1 General Overview of Methodology

EQ 2C will be a pre-post performance evaluation to determine the effect of any potential factors that influence maintenance policies and practices and how they could have been addressed to improve investment outcomes. Data collection for EQ 2C will overlap with the data collection required for EQ 2A. Therefore, the KIIs designed to inform EQ 2A will serve also to inform the EQ 2C.

VIII.1.2 Detailed Methodology

The evaluation team will determine the answers to EQ 2C through KIIs to the extent possible, complemented by secondary sources. Information will be drawn mainly from ANE and the Road Fund, to determine whether the factors within MCC's control that could have been effective in influencing maintenance policies on the MCC-financed road sections and assess sustainability. KIIs with stakeholders having close firsthand knowledge of maintenance policies and practices will be the main source of information. In consideration of stakeholders' time, IDG will first review available data from IMC, and the KIIs will only be conducted where necessary to corroborate or extend IMC's data, and kept to the briefest possible length needed for this purpose.

VIII.2 TIMEFRAME OF EXPOSURE

As part of that investment, the GOM committed to conduct ongoing periodic maintenance. Therefore, there should be sufficient evidence to determine whether the requirement was met, and the road fund was accurately funded as well as whether the funds have been used for maintenance since 2014, which will be verified with ANE and the Road Fund. ANE and the Road Fund will be asked whether any additional factors within MCC's control would have contributed to further improvement in road maintenance in the country.

VIII.3 PRIMARY DATA COLLECTION - KIIS

VIII.3.1 Sample Units

Key stakeholder organizations for road maintenance.

VIII.3.2 Sample Size and Associated Assumptions

In total, around 8-9 interviews are expected to be completed. Key stakeholders to be interviewed include relevant officials from the 1) ANE; 2) ANE technical staff; 3) Road Fund; 4) road maintenance contractors; 5) relevant municipalities; 6) donors active in the road sector (e.g., World Bank).

VIII.3.3 Sample Frame

A list of key stakeholders from each organization will be drafted by the evaluation team prior to data collection.

VIII.3.4 Sampling Strategy

Interviewees will be selected by the evaluation team based on their understanding of road maintenance practices and their involvement with the maintenance of the Nampula-Rio Ligonha and Namialo-Rio Lurio road.

VIII.3.5 Instruments

The team will conduct semi-structured interviews with a fairly open framework which allows for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data is collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries to obtain more specific information. Interviewees' responses will be transcribed on paper forms.

VIII.3.6 Rounds, Locations, and Timing

The KIIs will be conducted in July 2022. The interviews for EQ 2A will be combined with the interviews for addressing EQ 2B and EQ 2C to maximize the information gathered and optimize resources. Remote interviews will include stakeholders in Maputo and relevant villages/cities alongside the roads.

VIII.3.7 Respondent(s) within the Sample Unit

Representatives from key stakeholder organizations for road maintenance.

VIII.3.8 Staff

The evaluation team, led by the Team Leader/Road Maintenance Expert, will conduct the KIIs in English (and Portuguese, where needed), assisted by the In-Country Coordinator. While the Team Leader is a native Portuguese speaker, the stakeholders have expressed a preference for conducting the interviews in English, which will also allow other non-Portuguese-speaking evaluation team members to follow the discussion.

VIII.3.9 Data Processing

Given the travel restriction due to the COVID 19 pandemic, al KIIs will be conducted remotely via the Zoom platform and all meetings will be recorded and transcribed by the In-Country Coordinator. The evaluation team will also use the information available in the KIIs conducted by the previous evaluator IMC and ascertain whether the information is adequate to inform the overall content and methodology of IDG's EDR. The evaluation team will classify, sort, and arrange information gathered to identify trends and examine the relationships in the data using Taguette.

VIII.3.10 Data Quality

While the Team Leader/Road Maintenance Expert leads the interviews and takes notes, the In-Country Coordinator will assist the interviews by taking notes that will be used to cross-reference the notes taken by the Team Leader/Road Maintenance Expert. The notes will also capture non-verbal information (circumstances of the interview, emotions, body language, etc.). The transcript

will be reviewed by the Team Leader/Road Maintenance Expert within 24 hours of the interview. The team will cross-examine information when relevant to help build a body of evidence to support the analysis.

VIII.4 SUMMARY TABLE

A summary table of primary data collection is not included in this section because additional primary data collection is not required for EQ 2C.

VIII.5 SECONDARY QUANTITATIVE DATA

VIII.5.1 Limitations of Interpretation of the Results

The evaluation team will use secondary data collected under EQ 2A and 2B. However, given the nature of EQ 2C, most of the information needed to answer it is expected to emanate from the KIIs conducted for EQ 2A and 2B. A separate data collection is not required to address EQ 2C.

VIII.5.2 Requirements for Data Capture

There are no requirements for data capture as separate data collection will not be undertaken for EQ 2C.

VIII.6 ANALYSIS PLAN

Based on the secondary data collected and the qualitative data collected (KIIs), the team will examine the effect of the compact requirements and their impact on the road maintenance, as described under EQ 2B. During the KIIs conducted for EQ 2B, the Team Leader/Road Maintenance Expert will pose relevant questions to the interviewees to ascertain whether there is any additional action that MCC could have taken when designing the Compact, and which would have contributed to improve the country's road maintenance policies and practice.

Each indicator for EQ 2C will be analyzed as follows:

- Annual maintenance budget allocated for road maintenance:
    - Annual maintenance budget allocated for the road maintenance for the MCC-funded road and the road network (disaggregated by type of maintenance) will be determined by reviewing the budget allocated from ANE and the Road Fund (2011-2022).
    - Data gathered from secondary data will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data. If the budget allocated for road maintenance is low, the KIIs will be used to determine the factors that led to limited funding.
- Annual maintenance budget spent on road maintenance:
    - Annual actual maintenance expenditure on the road maintenance for the MCC-funded road and the road network (disaggregated by type of maintenance) will be determined by reviewing the budget allocated from ANE and the Road Fund (2011-2022).
    - Data gathered from secondary data will be corroborated with information obtained from KIIs to verify the accuracy of the secondary data.

- Quality of maintenance performed by ANE:
  - Road roughness study and the road condition study (visual inspection) will be used to determine the quality of emergency and routine maintenance performed on the MCC funded roads.
- Requirement for maintenance as mandated by MCC.

Based on the KIIs, the Team Leader/Road Maintenance Expert will determine the quality of maintenance performed.

VIII.7 CHALLENGES

VIII.7.1 Limitations of Interpretation of the Results

The interviews conducted by the team may be influenced by response bias. The stakeholders often have a strong incentive to hide their illicit activities, such as corruption or participating in informal economic ventures. Similarly, stakeholders may be biased to answer in a certain way for social or political incentives. Consequently, the team is likely to encounter difficulties in probing and understanding these issues, as well as ascertaining the true interests of the people engaged in such activities. Similarly, even if the purpose of the interviews is explained prior to the interviews, Mozambique government staff may want to show positive results from the Compact to justify further investments from MCC.

VIII.7.2 Risks to the Study Design

Secondary data sources and KIIs will be essential for answering EQ 2A. There is a risk that these documents may not be available to the evaluation team due to a delay in locating the documents, loss of past records, or unwillingness of the stakeholders to share sensitive information. Even when the documents are available to the team, the documents may be an inaccurate representation of the actual practice.

An additional risk is gathering accurate information from KIIs that the evaluation team cannot corroborate with data and/or documents. Interviewees may have biases and/or incentives to skew the information they provide to the evaluation team. To minimize these risks, we will interview all relevant institutional stakeholders for road maintenance, as well as private sector representatives, in order to validate the information from multiple perspectives. Furthermore, the road roughness study and the road condition study (visual inspection) will be an objective check of the appropriateness of the road maintenance standards being applied to the two MCC-financed roads.

IX. EVALUATION QUESTION 3A

3A) Who is travelling on the road, why, what are they transporting, what are they paying for transport, and how long does it take to move along key routes? [Results: Reduced Transportation Costs (actual), Generated and Diverted Traffic] How does road usage vary by road-user's income and gender?

IX.1 METHODOLOGY

IX.1.1 General Overview of Methodology

EQ 3A will be an ex-post performance evaluation examining the impact of the road improvement on the road users. This evaluation question will help identify the main beneficiaries of RRP (who is travelling on the road, what are they transporting) and how the road usage varies depending on the type of road user.

IX.1.2 Detailed Methodology

The evaluation team will mainly use the data collected under EQ 1 to inform EQ 3A. Mainly, data from the MTC, the O-D survey, and the travel time study will be used to inform the evaluation question. The evaluation team will also conduct a Public Transport User survey to determine MCC's effect on road usage patterns for those who use public transportation services.

IX.2 TIMEFRAME OF EXPOSURE

Time between works completion in October/November 2013 and survey will be approximately 8.5 years.

IX.3 PRIMARY DATA COLLECTION – TRAFFIC COUNT SURVEY

The traffic count will be used to determine the number of road users on the MCC-funded roads and their respective vehicle type in July 2022. Please see the note in section V.4.6 on this timing. A separate data collection is not required to address EQ 3A because the evaluation team will review the data collected for EQ 1 (see Section V.3 for more information). Additionally, some data will be used from the KIIs and data collection activities that were conducted by IMC's evaluation team.

IX.4 PRIMARY DATA COLLECTION – ORIGIN - DESTINATION SURVEY

An O-D survey will be used to determine who is travelling along the improved roads, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes. A separate data collection is not required to address EQ 3A because the evaluation team will conduct an O-D survey as part of EQ 1.

IX.5 PRIMARY DATA COLLECTION – PUBLIC TRANSPORT USER SURVEY

IX.5.1 Sample Units

Individual public transport users on board the buses traveling along the MCC-supported roads, and/or waiting at bus stations to board. See Annex VIII for discussion of the sampling approach.

IX.5.2 Sample Size and Associated Assumptions

The sample size will be finalized based on an analysis of traffic counts along the road segments, and when more information is available on bus capacity and occupancy rates for these buses and routes.

The goal is to obtain a representative sample so that the composition of the sampled passengers reflects the composition of all passengers who travel on the routes, with a reasonably high degree of confidence (e.g. 90% confidence interval). Based on SMEC 2009 traffic count, average vehicle occupancy rates of minibuses were 14 passengers, and of large buses occupancy rates of large buses was 40.[68]

IX.5.3 Sample Frame

The sample frame for the PTU survey is public transport users on buses traveling along the MCC-supported roads. These include passengers on buses that ply the entire route between Namialo-Rio Lurio and Nampula-Rio Ligonha (and beyond), and buses that ply only a shorter segment within the route.

The latest traffic count (December 2019) shows the following number of minibuses and buses plying the MCC roads:

Section	Minibus	Bus
Rio Ligonha - Nampula		
Rio Ligonha - 66 km	156	30
66 km - 98 km	227	39
98 km - Nampula	311	91
Rio Lurio - Namialo		
Rio Lurio - Alua	118	26
Alua - Nacaroa	136	52
Nacaroa - Namialo	269	67

Source: IMC

IX.5.4 Sampling Strategy

The interviewers will conduct the PTU survey by surveying passengers on board buses. This is based on the assumption that surveyors will travel along the part of the route, deliver the questionnaires to a randomly selected number of passengers and be available to answer questions

[68] SMEC, Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road –Phase 2: Detailed Design– Volume 2: Main Report, Chapter 3, p. 20

they have about filling in the survey. One or both methods will be adopted after they are piloted, depending on how effective they prove.

Passengers will be randomly selected for interviews at the Nampula and Namialo bus stations, while waiting for buses bound for Rio Lurio and Rio Linonha respectively and beyond.

The first two questions of the PTU questionnaire will be used to determine whether the participants meet the criteria (PTUs over 18 years of age), and willingness to participate in the survey.

IX.5.5 Instruments

The surveyors will either ask the passengers on public transport vehicles to respond to a short form on paper instead or have the survey questions administered verbally by an interviewer.

Filling out paper-based forms would mitigate the possibility that passengers may be reluctant to provide information that can be overheard by other passengers. However, they may interpret the questions differently without the surveyor available to explain what they mean. For example, "origin" can be interpreted in different ways (origin of the entire trip, or the bus trip).

Since the surveyors, in those cases where interviews are conducted on board the bus, and will be on the bus for an extended period, the team expects a higher response rate as well as more robust responses than from an O-D survey. The interview subjects will have more time to respond to the survey during their journey than at a road-side stop. Interview forms will also be available in Portuguese and other languages, as needed.

IX.5.6 Rounds, Locations, and Timing

The public transport survey will be administered a single time to passengers on buses along the MCC-supported road once the traffic data is analyzed and information on bus schedules is obtained.

IX.5.7 Respondents within the Sample Unit

Individual public transport users.

IX.5.8 Staff

The public transport survey will likely be contracted to the same subcontractor who conducts the O-D surveys unless a different firm is found to be cost-effective and offer more expertise in this area. The team sizes will be determined by the successful bidder, based on a competitive procurement process but the data collection team is likely to include one interviewer per bus, given the small sizes of the buses. The team will evaluate proposals from subcontractors to determine the best approach while considering location, data quality, and cost.

IX.5.9 Data Processing

The information obtained will be transcribed into Excel formatted worksheets. The data is intended to understand qualitative information on the road users and their travel patterns. The interviews will also uniquely inform Evaluation Area 3B providing information on how the infrastructure project has affected road usage that is not possible to obtain during the O-D survey which prioritizes questions on the cost and duration of the trips and value of the goods being transported to inform the HDM-4 model.

IX.5.10 Data Quality

A Supervisor from the subcontractor will be present when interviews are carried out and conduct a pilot test before the surveys are conducted. This will help mitigate the risk that data is not correctly recorded and plan for any anomalies that may be noted so that they can be rectified.

IX.5.11 Safety Procedures/Precautions

COVID-19 measures: The consulting firm hired to conduct the survey will be responsible for ensuring that all data collection teams adhere to the strict measures agreed with IDG to reduce the risks of COVID-19 transmission, by requiring data collection team to wear appropriate personal protective equipment (PPE) (face masks, face shields, and gloves etc.) as agreed with IDG and to maintain an appropriate distance from the respondents during interactions. The consulting firm will put in appropriate procedures to ensure that persons exhibiting symptoms are self-isolated at the lodging agreed. All personnel who were involved in data collection will be tested again if any persons exhibit symptoms.

IX.6 PRIMARY DATA COLLECTION – TRAVEL TIME STUDY

IX.6.1 Sample Units

The sample units are the MCC-funded roads between Namialo-Rio Lurio and Nampula-Rio Ligonha.

IX.6.2 Sample Size and Associated Assumptions

N/A

IX.6.3 Sample Frame

GPS coordinates of the starting points and the ending points of the Namialo-Rio Lurio and Nampula-Rio Ligonha are required to establish the starting and ending point of data collection.

IX.6.4 Sampling Strategy

N/A

IX.6.5 Instruments

The team will employ a test vehicle technique consisting of a vehicle dispatched to drive alongside the traffic under certain traffic scenarios for the purpose of data collection. A passenger in the test vehicle will record travel times at designated checkpoints or intervals using a clipboard and stopwatch and record vehicle speed, travel times, and distances.[69] The passenger will also record the length of time the vehicle was stopped at a traffic signal, a cross walk, or for any other reason. The guidelines for this survey provided by the US Department of Transportation will be followed.

IX.6.6 Rounds, Locations, and Timing

The project corridor will be travelled by the test vehicle two rounds, covering each time period representing peak traffic and lean traffic periods. Peak traffic and lean traffic periods will be

[69] FHWA, Travel Time Data Collection Handbook, 1998

identified from results of MTC. If there is more than 10% difference in travel time between the two rounds, a third round will be undertaken.

IX.6.7 Respondents within the Sample Unit

N/A

IX.6.8 Staff

The surveying team will consist of a driver and a trained technician that will record the travel time. The data collection might be subcontracted to the firm conducting the IRI data collection or one of the evaluation team members might conduct the survey while in the country with support from an experienced driver.

IX.6.9 Data Processing

Data will be entered using a double entry method, where the data entry operators will enter the data twice to identify mismatches. The mismatches will be corrected based on the original copy of the form. All raw data collected will be entered using data entry software with built-in quality checks for data entry.

IX.6.10 Data Quality

All rounds of data collection will be video recorded. The recorded data using the paper forms will be compared with the recordings.

IX.6.11 Safety Procedures/Precautions

Travel time needs to be measured under certain traffic conditions based on the scenario assumptions, therefore it does not require traffic to be diverted. Staff conducting the survey will remain in the vehicle at all times. Appropriate COVID 19 measures will be observed.

IX.7 SUMMARY TABLE

Table 8 Primary Data Collection Summary Table for Evaluation Question 3A

Data collection	Timing	Sample Unit/ Respondent	Sample Size	Relevant Instruments	Exposure Period
PTU	July 2022	PTU	To be finalized based on analysis of traffic counts along road segments, and information on bus capacity and occupancy rates.	Paper questionnaire	8.5 years
Travel Time Study	July 2022	Namialo-Rio Lurio and Nampula-Rio Ligonha project corridor	N/A	Paper form	8.5 years

IX.8 SECONDARY QUANTITATIVE DATA

IX.8.1 List of Secondary Data Sources

Secondary quantitative data is not required for EQ 3A.

IX.8.2 Requirements for Data Capture

Enumerators will need to speak local languages, as necessary. Data will be translated into English and transferred electronically.

IX.9 ANALYSIS PLAN

Data analysis software (e.g. Stata) will be used to analyze the results of the traffic count and O-D survey. The purpose of the analysis is to understand current road usage on the Namialo-Rio Lurio and Nampula-Rio Ligonha roads. The traffic count survey and the O-D data will be used to analyze the following parameters:

- MTC
  - Traffic volume by vehicle type for each direction of travel – As shared by ANE
- O-D survey
  - Frequency of travel
  - Key routes (origin-destination)
  - Travel time
  - Trip purpose
  - Cost of goods transported
  - Type of goods transported

  - Volume of goods transported
  - Value of goods transported
  - Education, gender, income, occupation, and vehicle ownership of road users
  - Is the condition of road a deterrent in using Namialo-Rio Lurio / Nampula-Rio Ligonha road?
  - Number and percentage of vehicles deterred (by type)
- PTU survey
  - Frequency of travel for PTUs
  - Key routes (origin-destination) for PTUs
  - Travel time for PTUs
  - Trip purpose for PTUs
  - Fares for passenger transportation
- Travel Time study
  - Average travel time

For O-D data, cordon lines and screen lines (imaginary lines drawn along natural/artificial boundaries) will be used to determine type of movement: through, external-internal, internal-external, internal. O-D matrices will be prepared for analyzing the O-D data. Each cell will give the number of trips made between pairs of traffic area zones (TAZs) between road sections, as delineated by cordon lines.

IX.10 CHALLENGES

IX.10.1 Limitations of Interpretation of the Results

Road user study results are dependent upon the quality of the data. Therefore, the O-D/PTU surveys must be a representative sample and the collected data must be carefully processed and analyzed.

O-D surveys by their nature provide short-term snapshots of road usage and representativeness can be difficult to assess. However, the limitation can be mitigated through maximizing practical duration and sample size, conducting surveys at complementary (and possibly overlapping) locations, a thorough set of interview questions including frequency of trip, and simultaneous traffic counts which are extended beyond O-D survey hours. With this in mind, the O-D survey is also being supplemented by the Public Transport User survey which will serve as an additional data source for comparison purposes with and enrich the findings of the O-D survey.

IX.10.2 Risks to the Study Design

The single most significant risk of the collected data is that of either insufficient or unrepresentative samples. Inevitably, the data collected will form a sample of the usage of the project road. Care will be taken to ensure that the samples obtained are both sufficient in size, dictated by duration of survey and sample rate, and representative of usage of the roads being surveyed as much as possible.

X. EVALUATION QUESTION 3B

3B) Have road usage patterns changed, in terms of who is travelling on the road, why, what they are transporting, what they are paying for transport, and how long it takes to move along key routes? [Results: Reduced Transportation Costs (actual), Generated and Diverted Traffic]

X.1 METHODOLOGY

X.1.1 General Overview of Methodology

EQ 3B will be a pre-post performance evaluation looking at how the road usage change before and after the road improvement. While EQ 3A looks at the post-Compact, present day usage of the road seven years after road improvement, EQ 3B will examine changes over time.

X.1.2 Detailed Methodology

Given that baseline information is limited to allow comparison with post-Compact data, retrospective questions will be asked during the O-D survey and PTU survey to construct a retrospective baseline. Data collection for EQ 3B will overlap with the data collection required for EQ 3A. Therefore, the PTU survey which is designed to inform Evaluation Question 3A will also serve to inform the Evaluation Question 3B.

Data collection for EQ 3B will overlap with the data collection required for EQ 3A. Therefore, the PTU survey which is designed to inform Evaluation Question 3A will also serve to inform the Evaluation Question 3B.

X.2 TIMEFRAME OF EXPOSURE

Time between works completion in October-November 2013 and survey will be approximately 8.5 years, but for before and after comparison, respondents will be asked to reflect on the pre-construction period, which increases the recall period to up to over 9 years. (Contracts for road rehabilitation were signed in June 2011 and works began after that point.)

X.3 PRIMARY DATA COLLECTION – TRAFFIC COUNT SURVEY

The traffic count will be used to determine the number of road users on the MCC-funded roads and their respective vehicle type in July 2022. Please see the note in section V.4.6 on this timing. A separate data collection is not required to address EQ 3A because the evaluation team will review the data available from EQ 1 (see Section 5.3 for more information). Additionally, some data will be used from the KIIs and data collection activities that were conducted by IMC's evaluation team.

X.4 PRIMARY DATA COLLECTION – ORIGIN - DESTINATION SURVEY

To address the changes over time, the O-D survey question topics used for 3A will ask retrospective questions about road usage by the respondent before the road improvement. Relevant question topics will have three parts to it. For example, i) travel time in reference to the present

trip/route; ii) whether the respondent used the Namialo-Rio Lurio and Nampula-Rio Ligonha roads before the rehabilitation and if iii) travel time in reference to the before period. The last question may be formulated as “please remember the last trip you took before the Namialo-Rio Lurio and Nampula-Rio Ligonha roads were rehabilitated."

Data based on recall, especially for a period that is seven or more years in the past, will not be as reliable as data collected during baseline would have been. Therefore, the validity of results will necessarily be weaker and estimated changes be treated as indicative. Certain question categories will likely yield more reliable answers than others. For example, recall on volume and value of goods in the pre-Compact period may be very difficult to answer, especially since this may well have been dependent on the trip in question.

X.5 PRIMARY DATA COLLECTION – PUBLIC TRANSPORT USER SURVEY

The PTU survey will ask retrospective questions about the road usage before the road improvement.

As with the O-D survey, questions will have three parts, referring to: i) the current trip; ii) whether the route was traveled in the pre-Compact period and, if yes, iii) referring to the trip in the past.

An additional, qualitative question may be added, asking the respondent to describe the biggest difference or the main benefit that they have experienced as a result of the new road. The question could be followed up by asking whether the respondent had experienced any economic benefits. This qualitative information would help the evaluation team interpret the survey results.

X.6 SUMMARY TABLE

Summary table of primary data collection is not included in this section because additional primary data collection is not required for EQ 3B.

X.7 SECONDARY QUANTITATIVE DATA

X.7.1 List of Secondary Data Sources

The evaluation team will use secondary data to provide some relevant baseline information as available:

- MTC conducted on the Namialo-Rio Lurio and Nampula-Rio Ligonha roads prior to road improvement by SMEC/Jacobs.
- O-D survey on the Namialo-Rio Lurio and Nampula-Rio Ligonha road prior to road improvement by SMEC/Jacobs.

X.7.2 Requirements for Data Capture

Enumerators will need to speak local languages, as necessary. Data will be translated into English and transferred electronically.

X.8 ANALYSIS PLAN

Evaluation Question 3B will focus on analysis of change in these factors before and after the Compact.

Pre- and post-project data will be summarized in frequency distribution tables. The following road user characteristics will be analyzed:

O-D survey

- Education, gender, income, occupation, and vehicle ownership of road users
- Frequency of travel
- Key routes (origin-destination)
- Travel time
- Trip purpose
- Fares for goods transported
- Type of goods transported
- Volume of goods transported
- Value of goods transported

In order to address how road traffic patterns have changed in terms of volume, changes in traffic volume on project roads will be analyzed, with respect to non-project roads. Although this is not an impact evaluation, some counterfactual information can be obtained from other roads in Mozambique. Traffic volumes, and vehicle registrations, are known to have increased in the country over the past decade. The changes in traffic volume on the Namialo-Rio Lurio and Nampula-Rio Ligonha roads will therefore be compared with changes in traffic volumes on other roads, to assess whether any Namialo-Rio Lurio and Nampula-Rio Ligonha roads increases are disproportionate. The possible effect of the COVID-19 on economic and leisure activity will need to be taken into consideration.

Comparisons of means from the data will be done using an appropriate statistical test, e.g. independent samples t-test, one-way Analysis of Variance (ANOVA), etc.

Additional analysis will be conducted to assess explanatory variables, e.g. independent factors that might explain the observed outcomes.

X.9 CHALLENGES

X.9.1 Limitations of Interpretation of the Results

Road user study results are dependent upon the quality of the data. Therefore, the O-D/PTU surveys must be a representative sample and the collected data must be carefully processed and analyzed.

O-D surveys by their nature provide short-term snapshots of road usage and representativeness can be difficult to assess. However, the limitation can be mitigated through maximizing practical duration and sample size, conducting surveys at complementary (and possibly overlapping) locations, a thorough set of interview questions including frequency of trip, and simultaneous traffic counts which are extended beyond O-D survey hours. With this in mind, the O-D survey is also being supplemented by the Public Transport User survey which will serve as an additional data source for comparison purposes with and enrich the findings of the O-D survey

An additional limitation is the use of recall method. Since baseline information is limited, the O-D survey and PTU participants will be asked to remember and report on the period before the road was improved in 2011 Interviewees and participants may have poor recollection of the public transport usage prior to the Namialo-Rio Lurio and Nampula-Rio Ligonha roads improvement.

X.9.2 Risks to the Study Design

The largest risk to the study is that not enough persons recollect the period before construction, and that those who do not recollect the period with enough accuracy to provide reliable data. Related to this is the risk that the collected data is not a representative sample. Care will be taken to ensure that the samples obtained are both sufficient in size, dictated by duration of survey and sample rate, and representative of usage of the roads being surveyed as much as possible.

XI. EVALUATION QUESTION 4

4) Given the existing transportation market structure, what portion of VOC savings will be passed on to consumers of transportation services? If not all savings are passed on, how could this project have cost effectively addressed these inefficiencies? [Result: Reduced Transportation Costs]

XI.1 METHODOLOGY

XI.1.1 General Overview of Methodology

EQ 4 will be addressed using an ex-post performance evaluation examining the distribution of road user benefits stemming from VOC savings. Addressing EQ 4 will involve testing whether the reduced VOC eventually led to reduced costs for transportation services, both for passengers and for freight. (Reasons why the reduced VOC might not result in reduced costs include: transportation providers capturing the benefit and not passing on savings to customers, regulations which restrict price changes, or reduced VOC on the Namialo-Rio Lurio and Nampula-Rio Ligonha roads being offset by higher VOC on other roads which the vehicles travel on, and costs such as gasoline prices outweighing the VOC reduction benefit.)

XI.1.2 Detailed Methodology

EQ 4 will employ a mixed-methods approach to answer the evaluation question. Information will be drawn from secondary sources to analyze the transportation market structure, changes over time, and the formal and informal institutions that regulate and govern the transportation market.

To answer EQ 4, the evaluation team will:

- Analyze the regulatory framework of the sector, in terms of shipping costs applied to freight and fares applied to passengers;
- Assess the gap between enacted and enforced regulations;
- Analyze the structure and composition of transportation cost;
- Identify the modalities of pricing of transportation services.

XI.2 TIMEFRAME OF EXPOSURE

It is assumed that the drivers of VOC changed immediately upon completion of the road improvements in October/November 2013. Therefore, it would have provided transportation service providers, both formal and informal, at least seven years (from early 2014 to 2021) for the effects to be noticed to adjust to the reduced VOC, depending on what share of total travel that travel on the rehabilitated road segments represents. For example, if a truck mainly plies the route Maputo – Pemba (2,440 km) then the 252 km of MCC rehabilitated roads represent just over 10% of the total route, and VOC impact would be one tenth of what it would be if the entire N1 had been rehabilitated. If the rest of the N1 is not maintained and is allowed to deteriorate, then the RRP investment would have been futile.

XI.3 PRIMARY DATA COLLECTION – ORIGIN-DESTINATION SURVEY

The O-D survey will be used to determine how much road users are paying for transport. A separate data collection methodology is not required to address EQ 4 because the evaluation team will be able to use O-D survey collected as part of EQ 1.

XI.4 PRIMARY DATA COLLECTION – PUBLIC TRANSPORT USER SURVEY

PTU will be used to determine how much public transport users are paying for passenger transportation services. A separate data collection is not required to address EQ 4 because the evaluation team will conduct PTU as part of EQ 3A. This will be combined with information from transportation providers collected through KIIs.

XI.5 PRIMARY DATA COLLECTION – KIIS

XI.5.1 Sample Units

Key stakeholder organizations in transportation market.

XI.5.2 Sample Size and Associated Assumptions

Key stakeholders to be interviewed include:

i) public transportation service providers and associations (of short and long-distance bus routes that ply the Namialo-Rio Lurio and Nampula-Rio Ligonha roads)

ii) goods transporters operators and associations plying the route

iii) transport service regulators (ANE, Provincial Directorate of Transport and Communication (within INATTER), provincial governments/municipalities) to understand the transport policies and their impacts

In total, around 6 to 9 interviews are expected to be completed, 2-3 interviews per target respondent group.

XI.5.3 Sample Frame

A list of key stakeholders will be drafted by the evaluation team prior to data collection. The evaluation team will identify the relevant person to conduct KIIs at the relevant regulatory agency, transportation companies, and public transport associations. For the goods transporters, the evaluation team will compile a list of transporters that operate (or have the potential to operate) using the Namialo-Rio Lurio and Nampula-Rio Ligonha roads.

XI.5.4 Sampling Strategy

A small number of interviews will be conducted with key informants for each organization and therefore sampling is not required. For both public transportation companies and goods transporters, the representatives will be selected based on the location and the size of their operations.

XI.5.5 Instruments

The team will conduct semi-structured interviews with a fairly open framework which allows for focused, conversational, two-way communication. Semi-structured interviews ensure that consistent data is collected yet provide opportunities for an individual to offer their perspectives on the relative importance of any factor. The team will ask questions based on the evaluation questions described above and follow-up with relevant inquiries to obtain more specific information. Interviewees' responses will be transcribed on paper forms.

The KII questionnaires will help to address questions regarding the structure and economics of the transport sector that arise from the document review, focusing on the following details:

- Industry structure, types of operators, average vehicle fleet, number of vehicles owned
- Operating practices such as:
    - Cultural factors affecting the service providers and users
    - Acquisition of modern vehicles
    - Maintenance of vehicles
    - Overloading
    - Informal payments
    - Transportation service prices
    - Operating practices
    - Regulatory policies and actual enforcement of regulations
- Regulatory policies and enforcement such as:
    - Freight sharing rules
    - Queuing systems
    - Third country rule, cabotage, and backhaul regulations
    - Axle load limits
    - Border crossings
    - Roadblocks and checkpoints
    - Transit agreements
    - Domestic transport regulations

XI.5.6 Rounds, Locations, and Timing

KIIs will be conducted in July 2022 and coincide with one of the road-user surveys. The KIIs will be conducted in Maputo or other locations in Mozambique depending on the interviews.

XI.5.7 Respondent(s) within the Sample Unit

Representatives from key stakeholder organizations in the transportation market.

XI.5.8 Staff

The Evaluation Expert will conduct KIIs in English, assisted by the In-Country Coordinator.

XI.5.9 Data Processing

The Evaluation Expert will conduct the KIIs in English, assisted by the In-Country Coordinator. All KIIs will be audio-recorded on digital voice recorders and transcribed by the In-Country Coordinator. The evaluation team will classify, sort, and arrange information gathered to identify trends and examine the relationships in the data using Taguette.

XI.5.10 Data Quality

The notes taken by the Evaluation Expert and the In-Country Coordinator will be cross-checked. The notes will capture non-verbal information (circumstances of the interview, emotions, body language etc.). The transcript will be reviewed by the Evaluation Expert within 24 hours of the interview. The team will cross-examine KII notes against other sources of information, when available, to validate the analysis.

XI.5.11 Safety Procedures/Precautions

N/A

XI.6 SUMMARY TABLE

Table 9 Primary Data Collection Summary Table for Evaluation Question 4

Data collection	Timing	Sample Unit/ Respondent	Sample Size	Relevant Instruments	Exposure Period
KIIs	July 2022	Transporter/ public transport associations, goods transporters, regulators, and ANE	8-10	KII questionnaire	8.5 years

XI.7 SECONDARY DATA

XI.7.1 List of Secondary Data Sources

The evaluation team will collect secondary data from various sources to address EQ 4. The team will mainly collect the documents from ANE, municipalities, transport associations, and private transportation contractors (medium and small-sized). The evaluation will attempt to obtain the following documents as available:

- Transportation market regulations, policies, and processes
- Historical records of transportation prices for passenger and goods transportation
- External assessments (by international donors etc.) on the Mozambique' transportation regulations

XI.7.2 Requirements for Data Capture

When the team is unable to obtain relevant documents in English, The Team Leader, a native Portuguese speaker, will review the documents and recommend the sections that should be professionally translated for the purpose of the evaluation. If data is only available in paper form, data will be inputted into Excel accordingly. If available in an electronic format, the documents will be transferred electronically.

XI.8 ANALYSIS PLAN

The team will examine the transportation market to evaluate whether GOM's institutional, financial, and technical aspects of the transportation sector are adequate in comparison to international standards.

Changes in:

- Transport Cost Determination
- Monitoring
- Enforcement of regulations
- Permit issuance
- Number of participants (trucking and bus companies)
- Informal market participants
- Transport market competitiveness, including number of firms, barriers to entry, informal activity

Based on the analysis of the transportation market structure, the evaluation will review the regulations and historical trend of transportation costs to determine the portion of VOC savings that will be passed on to consumers of transportation services. The analysis will also assess what factors contribute to changes in costs, beyond IRI.

XI.9 CHALLENGES

XI.9.1 Limitations of Interpretation of the Results

The interviews may be subject to response bias, stakeholders to answer in a certain way for social or political incentives. Consequently, the team is likely to encounter difficulties in probing and understanding these issues, as well as ascertaining the true interests of the people engaged in such activities. Similarly, even if the purpose of the interviews is explained prior to the interviews, Mozambican government staff may want to show positive results from the Compact to justify further investments from MCC. Some stakeholders may have an incentive to hide informal activities, such as overloading, not declaring passenger or cargo receipts, etc.

XI.9.2 Risks to the Study Design

Secondary data sources and KIIs will be essential for answering EQ 2A. There is a risk that these documents may not be available to the evaluation team due to a delay in locating the documents, loss of past records, or unwillingness of the stakeholders to share sensitive information. Even when the documents are available to the team, the documents may be an inaccurate representation of the actual practice.

An additional risk is gathering accurate information from KIIs that the evaluation team cannot corroborate with data and/or documents. Interviewees may have biases and/or incentives to skew the information they provide to the evaluation team. To minimize these risks, we will interview all relevant institutional stakeholders for road maintenance in order to validate the information from multiple perspectives.

XII. ADMINISTRATIVE

XII.1 SUMMARY OF IRB REQUIREMENTS AND CLEARANCES

The Evaluation Team will prepare and submit an Institutional Review Board (IRB) application to an IRB registered with the Office for Human Research Protections with the US Department of Health and Human Services (if possible, the IRB will be in Mozambique) for approval of the research and data collection plan involving human subjects.

The application materials for IRB will include four sets of documents at minimum: 1) a copy of the Design Report, 2) a copy of survey protocol, 3) copies of all data collection instruments that will be used for the survey, and 4) a completed IRB application form summarizing the protection of participants' rights and data safety.

All survey and interview procedures will be based on the principles of voluntary participation and informed consent. Prior to participating in the survey, respondents will be given sufficient information on the objective of the survey and the use of the data collected in order to inform their decision about whether or not they wish to participate in the survey. The informed consent statement will closely follow the guidelines provided by MCC.

XII.2 APPROVAL FROM LOCAL AUTHORITIES

For the collection of field data, the evaluation team will contact the necessary authorities early and work closely to ensure their timely cooperation. The team, with assistance from data collection firms, will acquire official approval for data collection from the police, weight station authorities, and toll stations.

XII.3 DATA PROTECTION, ACCESS, AND DOCUMENTATION

The study will ensure that the confidentiality of information obtained from or about human participants is maintained. The evaluation team will ensure that the raw datasets are cleaned and de-identified closely following MCC's guidelines for public use of data. The evaluation team will also ensure that all data collection agencies also adhere to this high standard of confidentiality and data security. The obtained data will be stored in a secured server with access limited to project personnel who signed the non-disclosure agreement.

The evaluation team will provide a clean, de-identified dataset to MCC for public and internal use. The dataset will be free of personal or geographic identifiers that would allow for the identification of individual respondents. Any additional variables which risk divulging the identity of individual subjects will be removed. In order to facilitate access to and usability of data, all datasets delivered to MCC will be accompanied with completed documentation in the form of standardized metadata. In accordance with MCC's Guidelines for Transparent, Reproducible, and Ethical Data and Documentation, IDG will submit the raw, identifiable data only if there is a specific need to transfer the evaluation to another contractor or to follow up with interview subjects.[70]

[70]MCC, Guidelines for Transparent, Reproducible, and Ethical Data and Documentation, https://www.mcc.gov/resources/pub-full/guidance-mcc-guidelines-tredd

XII.4 DISSEMINATION PLAN

A draft Evaluation Report will be submitted to MCC in December 2022 with the final independent CBA model. The evaluation team will also submit the final datasets (a raw dataset and a clean dataset) and the analysis files. Feedback from MCC and local stakeholders will be incorporated to produce the final data collection report. Upon review by the Evaluation Management Committee (EMC), the evaluation team will present the results of the data collection in Mozambique and Washington DC. The evaluation team will deliver the entire contents of the project library in good order, properly indexed and marked, in both digital and paper copy to MCC.

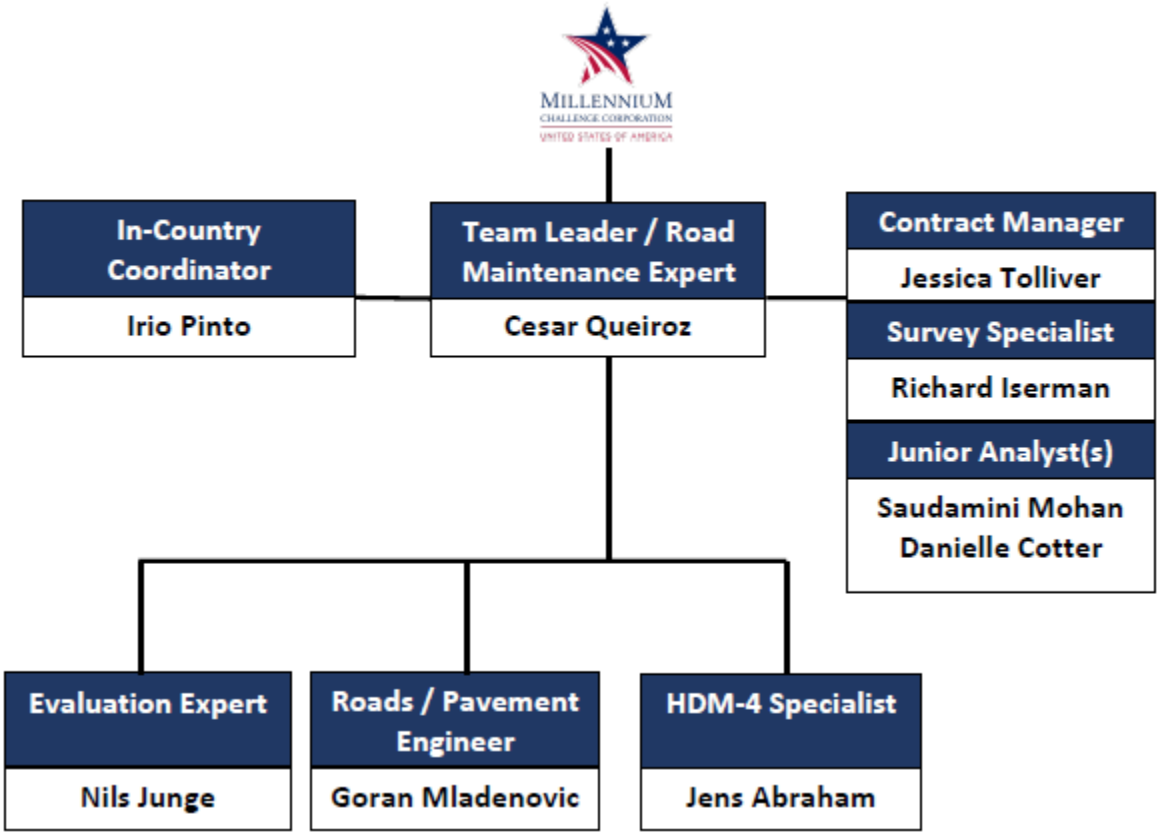
XII.5 EVALUATION TEAM ROLES AND RESPONSIBILITIES

The evaluation team has five key personnel that work closely together for evaluation. The table below presents each of the key personnel on the Evaluation Team and their responsibilities. The support team will provide technical and administrative capacity to carry out the project activities and achieve MCC's goal and objectives. The diagram (Figure 5) below shows the organizational chart of the complete evaluation team.

Table 10 Evaluation Team and Responsibilities

Name	Position	Responsibility
Cesar Queiroz	Team Leader/Road Maintenance Expert	• Evaluation Coordination and Quality Control • Technical lead for the evaluation of Evaluation Area 2 on road maintenance
Jens Abraham	HDM-4 Specialist	• Technical lead for Evaluation of Evaluation Area 1: Engineering Analysis and Economic Model • Technical lead for the evaluation of Evaluation Area 4: Transportation Market Structure • Technical support for the evaluation of Evaluation Area 3: Road Usage Patterns • Technical support for the evaluation of Evaluation Area 2: Maintenance
Goran Mladenovic	Roads/Pavement Engineer	• Technical support for the evaluation of Evaluation Area 1: Engineering Analysis and Economic Model, especially for the roughness study, the road condition survey, the deflection measurement study, and the geotechnical study • Technical support for the evaluation of Evaluation Area 2: Maintenance, especially for assisting the analysis of road maintenance quality
Nils Junge	Evaluation Expert	• Technical lead for the evaluation of Evaluation Area 3: Road Usage Patterns • Technical support for Evaluation of Evaluation Area 4: Transportation Market Structure
Irio Pinto	In-Country Coordinator	• Assist the team to arrange meetings with different stakeholders and facilitate the data collection procedures

Figure 5 Evaluation Team Organization Chart



XII.6 EVALUATION TIMELINE & REPORTING SCHEDULE

Table 11 Summary of Evaluation Timeline and Reporting Schedule

Name of Round	Data Collection	Data Cleaning & Analysis	First Draft Report Expected	Final Draft Report Expected
Post-Compact	*July 2022*	*August 2022 – November 2022*	*December 2022*	*June 2023*

The work plan for the evaluation is outlined in **Annex II**. The plan accounts for each of the major deliverables along with the expected timeline of the evaluation.

ANNEX I: REFERENCES

African Development Bank. *Mozambique: Montepuez to Lichinga Road Project*. Februray 2021

AASHTO. *Guide for Design of Pavement Structures, American Association of State Highway and Transportation Officials*. 1993.

AICD. *Mozambique's Infrastructure: A Continental Perspective*, ppiaf.org/documents/3152/download.

Government of Mozambique. *ANE-Integrated Feeder Roads Development Project*. 2019

International Monetary Fund. *Mozambique Rising: Building a New Tomorrow*. 2014

MCA-Mozambique. *Monitoring and Evaluation Plan*. 2013.

Millennium Challenge Corporation. *Independent Evaluation Management Guidance - External.* 2020.

Millennium Challenge Corporation. *Millennium Challenge Compact between the United States acting through the Millennium Challenge Corporation and the Republic of Mozambique.*

Millennium Challenge Corporation. *Principles into Practice, Lessons from MCC's Investments in Roads.* 2017.

Sloman, Lynn, Hopkinson Lisa, and Taylor Ian. "The Impact of Road Projects in England." 2017.

Tetra Tech. *Feasibility Study,* 9-18. 2020.

World Road Association. *Highway Development & Management, Volume Five: A Guide to Calibration and Adaptation.* 2000.

ANNEX II: COMMENTS AND EVALUATION RESPONSES

Page	Text	Comment #	Comment	IDG Response	Comment date
	MCC COMMENTS				
	General	1	Overall, there are a lot of comments, including to-be-determined design elements, places where the evaluation questions were not addressed, and places where the outline was not adequately followed, and it takes MCC a lot of time to review and craft all of these comments. Please ensure the next version is complete, and please proactively reach out to the PM if you have questions, so as to minimize the number of reviews that we have to do.	Noted	May 5, 2021
1	Section 1.2, first paragraph	2	Evaluation area 1 is mainly a performance evaluation around reductions in transportation costs	Revised	May 5, 2021
1	Section 1.2, "to complement and enhance knowledge gained through the economic analysis"	3	This isn't accurate. The economic analysis helps us understand whether the investment was cost-effective, but it's not the central focus of the evaluation.	Removed	May 5, 2021
2	Section II.I.I "The overarching objective of the Roads Project is four-fold:"	4	Please specify where this is from in a citation (should be section 1.2 of the compact agreement, that's where the objective always is)	Added	May 5, 2021
2	Section II.I.I last two sentences	5	Both of these sentences need a citation please	Added	May 5, 2021
2	data shared by MCC from the EDR prepared by IMC Worldwide	6	More accurate to say "IDG's EDR builds on data shared by MCC which was collected as a part of the IMC evaluation" rather than connecting the data to the EDR.	Revised	May 5, 2021
2	following approval of the IMC report	7	"Ahead of the procurement of this evaluation" may be more accurate since	Revised	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
			"following" gives the impression the questions were changed for IMC as well		
3	expected to benefit	8	Can you elaborate a little here? Expected by the Beneficiary Analysis? By GoM in other documentation? Whose expectation?	The Beneficiary Analysis in the Compact stated that over 50% of the population in the two provinces of Nampula and Cabo Delgado are of working age and were expected to benefit with increased employment after the roads had been developed.	May 5, 2021
4	II.I.3.1 and Table II.1	9	Please do not use the Compact Completion Report as a source for data, the Closeout ITT has the offical data.	Done. Data taken from the Mozambique RRP Indicator Tracking Table.	May 5, 2021
5	The Namialo-Rio Lurio section of the road is expected to see an increment of approximately 16% in average annual daily traffic volume and the Nampula- Rio Ligonha segment is expected to have an increase of 19% in average annual traffic.	10	Expected when/as of when – I assume this has already occurred? These probably got pulled from different reports but they're a little unclear here stripped of their context.	This reference was taken from MCC's Investment Memo and has therefore been deleted from the EDR.	May 5, 2021
5	would have benefitted from…	11	The conditional makes this slightly confusing – is this drawing on the post-Compact ERR?	Taken from the Mozambique RRP Indicator Tracking Table.	May 5, 2021
5	II.I.3.1, last two paragraphs	12	These aren't appropriate to have in an EDR or in a section describing the project to date - it appears to be unverified or supported claims of results, possibly copied from an MCC narrative but not produced by the evaluator as part of the evaluation. What would be helpful instead would be a table showing what was planned in the compact document, versus the modification, versus actually implemented	Done. There is a table indicating initial RRP plan, as shared in the Compact, and one indicating the final completed segments.	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
			(by closeout, and then ultimately). Be sure to account for all activities in the project.		
6	II.2.1, first sentence	13	needs citation	Revised	May 5, 2021
8	II.3.1	14	add section for Modification ERR	Revised	May 5, 2021
8	II.3.1 and III.2, Table III.1	15	please don't cite decisional documents in these public documents or use PII. PM can provide further guidance. This comment also applies to Annex VII (Evaluability Assessment, which extensively cites the IM)	Removed reference to IM and FDD report and replaced with data from M&E reports. The overall report has been reviewed for references to internal documents.	May 5, 2021
9	footnote 12	16	didn't understand what you were trying to say in this footnote - please re-word	Revised	May 5, 2021
9	II.3.1, "The maintenance assumption used for the ERR reported in the M&E plan is not reported."	17	please state clearly (somewhere in the EDR) which HDM-4 files of MCC's you have, and which you do not	The model inputs are accessible, but HDM software is unable to generate output from these files. The team will be able to use the inputs provided to regenerate HDM model, but assumptions (including cash flow assumptions) are not available using this approach.	May 5, 2021
10	II.3.1, "which notes the pre-Compact ERR as being..."	18	I didn't understand this sentence, can you please re-word	Revised	May 5, 2021
10	II.3.2, last sentence	19	Analysis plans should be in the analysis section, not here	Revised	May 5, 2021
10	II.4, second sentence	20	I think you mean "were expected to be in", since this was stated ex-ante (and a statement of current fact isn't available yet)	Correct. Revised	May 5, 2021
10	II.5.1	21	This section should be a summary of relevant literature on the evaluation questions (citing specific studies), not background information on the evaluation questions. The section currently seems to have a little bit of both. If there's no relevant literature, you can just say so. The background information is useful but suggest moving it to elsewhere in the report. Please look at other EDRs on MCC's website	Done. We have updated the literature.	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
			and cite those, do not spend time re-creating what we already have.		
10	Footnote 13	22	I think this is supposed to be a link?	It was a file reference. Now included in the text	May 5, 2021
10	The HDM-4 model is also available	23	To what end is it available? Is it different/similar? Will it be used?	Text added	May 5, 2021
12	EQ 2b "The conditions precedent…"	24	There was no conditions precedent like this in this compact. Please read the evaluation question carefully - we adjusted the wording for this reason, this language is different from a CP. This needs to be revised throughout the report.	Revised throughout the report.	May 5, 2021
13	EQ 2b "As a result of those requirements"	25	How can you say with confidence that it is "as a result of" the MCC investment? That methodology should be laid out in the EDR before an analysis is conducted (and I question whether determination of a causal relationship is possible in this case). Please put answers to the evaluation questions in the final report, not the design report	Revised	May 5, 2021
14	II.5.2	26	This section should be a summary of relevant gaps in the literature on the evaluation questions (lack of relevant specific studies), not background information on the evaluation questions. Also, EQ 4 looks like a summary of the literature?	Done. We have updated the text and highlighted gaps in the literature	May 5, 2021
15	II.5.2, 3A/3B, "However, many of the evaluations are currently ongoing and not available now."	27	This isn't accurate, we have four evaluations posted now - please take a look at those.	Done. We have updated the text.	May 5, 2021
17	III.1 Evaluation Area 1	28	This needs to be revised, please re-read the evaluation questions. The CBA is a sub-question, but not the focus of this evaluation area. The focus is the performance evaluation of whether or not the project reduced transportation costs.	Revised	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
17	III.1 Evaluation Area 3	29	The purpose is to understand the theory of change between reduced transportation costs and goal	Revised	May 5, 2021
19	III.2, Table III.2	30	Please include a separate row for each data source, and a column for the baseline source and endline source. Add column for whether or not IMC collected the data. If IMC collected but IDG is recommending to re-do, add column with short (one phrase) justification	We have updated the table as per MCC's guidance	May 5, 2021
20	III.2, Table III.2	31	Please don't use the term "secondary sources", specify the document name	Done. The text has been revised.	May 5, 2021
21	Footnote 33	32	Please note the name of the document	Done.	May 5, 2021
21	III.2, "EQ 1 will not be comparing baseline and endline values directly but rather analyzing the different scenarios with and without the RRP. "	33	Would make sense to reference and explain the methodology here, as it is done for all of the other Eqs (modelling)	Revised	May 5, 2021
21	III.2, "EQ 2B will employ pre-post…"	34	Would make sense to explain where the "pre" will come from, as it is explained for the other questions	Revised	May 5, 2021
22	III.2, Table III.1	35	Please be sure to use all relevant indicators from the revised common indicators for Transport, and match the indicator to that list (definition, unit, etc must all match). PM can share revised list if not yet posted.	Done. We have used the Common Indicator List shared by the PM and made relevant changes.	May 5, 2021
22	III.2, Table III.1	36	The "post-compact" column says "proposed new data source" but some of the baseline sources are "proposed new sources" as well. Please be sure the baseline source is documented for all pre-post and modelling methodologies	Revised	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
22	III.2, Table III.1	37	Several of these indicators do not match the definition of an indicator. It needs to be quantitative. I think consulting the common indicator list will help, but if you aren't able to identify the appropriate indicators, please ask the PM for help before re-submitting. Please remove rows that are not indicators.	Done. Non-quantitative indicators have been removed. We have used the Common Indicator List shared by the PM and made relevant changes, including inserting references to common indicators where used.	May 5, 2021
22	III.2, Table III.1	38	What is the "End of Compact Review"?	This is the 2014 Review conducted by Jacobs.	May 5, 2021
22	III.2, Table III.1	39	Suggest consulting previous MCA staff if possible, for EQ 0	Revised	May 5, 2021
22	III.2, Table III.1	40	Should use the M&E Plan baseline if it exists for a given indicator, unless you have concerns about the value, but please specify why	Revised	May 5, 2021
22	III.2, Table III.1	41	Please be sure the source specifies what IDG recommends, not "IDG or IMC data"	Revised	May 5, 2021
22	III.2, Table III.1, roughness	42	Baseline seems low	The baseline is based on the sources cited.	May 5, 2021
22	III.2, Table III.1	43	Combine 3A and 3B into one in this table. Because it is pre-post, the difference between the baseline and endline will be used, but we want to see that the indicators are the same for 3A and 3B	Revised	May 5, 2021
22	III.2, Table III.1, EQ 4	44	The sources need to precisely show how the indicator defined here will be collected. Not clear where “Estimated vehicle operating cost savings that are passed on to transport consumers” comes from nor the denominator, and that is all that we need.	Revised	May 5, 2021
33	IV.4, Table IV.1, Exposure period	45	Exposure period is not applied here correctly, exposure period is the time from when the road was finished until today	Revised	May 5, 2021
34	V.I	46	Please revise this section to address the evaluation questions	Revised	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
34	V.2	47	Please refer to the evaluation question that references this. State the magnitude in the CBA that is relevant for when data will be collected. Sampling section should explain you are powered to detect that magnitude.	Revised to address this comment.	May 5, 2021
36	V.3.6 Therefore, a decision on whether to use the 2019 count data or to undertake a new traffic count will have to be taken after a field assessment.	48	This should ideally be determined before the EDR is final. Is it possible for the local coordinator to do? If not, specify what indicators will be looked at to make the decision.	Revised	May 5, 2021
37	V.3.6 The locations will be proposed by ANE or based on that of the feasibility study count or a location that best represents the section traffic based on the field reconnaissance	49	If you change the location, how will you know whether the change in traffic from baseline is due to an increase in traffic versus a more representative location choice?	The suggestion was based on variation observed in 2019 counts of ANE and IMC at some locations. It is now revised to have counts at feasibility study location and add few one day counts if some sub-sections are observed to have substantially different traffic than at the count station representing the section. This is particularly important at urban section close to towns. If urban section is 6 km and say count is towards the end of the section, there is a possibility that last 3 km of urban section close to town show a much larger increase in traffic due to town expansion. Substantial additional benefits added by the project can be captured with this.	May 5, 2021
39	V.4.4	50	This needs to be more specific. What is the sampling rate for each vehicle and how do you determine it to ensure it is representative? Must have a strong rationale. See Philippines design report.	Revised	May 5, 2021
39	V.4.6	51	Please provide a map	The map in Annex III has been updated, and this section has been revised to include a reference to this map.	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
40	V.4.6 "The selection of the locations is designed to capture traffic at the beginning and the end of the road sections"	52	We want the locations to be representative of the segment as a whole (see common indicators). Please explain why this is the case for each.	Explanation has been added	May 5, 2021
41	V.5 " A review of the input data will be undertaken to assess an update is needed using primary surveys or update using inflation to bring all costs the selected analysis year"	53	This review needs to be done before submission of the revised EDR	Revised	May 5, 2021
42	V.5.6, "The survey will take place in Nampula primarily and Maputo (especially for vehicle dealers)."	54	What is the rationale for these locations? What evidence is there that the traffic on the road is buying vehicle parts/vehicles from these locations?	IDG will use VOC data from IMC rather than conducting a new survey at these locations. The report has been revised to reflect this change.	May 5, 2021
41	V.5	55	Here and in the budget it isn't clear whether this is being collected by the HDM-4 specialist or a survey firm	IDG's stakeholder meetings with ANE during the EDR preparation showed that they are collecting HDM-4 data as part of their planning process. This data will be used.	May 5, 2021
47	V.9.1	56	List is missing	Revised	May 5, 2021
48	V.10	57	Please revise to cover all evaluation sub-questions that belong here, this isn't comprehensive.	Revised	May 5, 2021
49	V11.2 "this also poses a major risk to the data quality and data availability. "	58	Please explain why you are still recommending the approach that you are, given these risks	Revised	May 5, 2021
49	V.11.2	59	first but no "second"	Revised	May 5, 2021
50	Vi.2	60	Great section!	Thank you for this feedback!	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
50	VI.3 and VIII - KIIs	61	IMC's data needs to be assessed before proposing to bother the same people for KIIs - we should be careful here, and considerate of stakeholders' time.	Revised to reflect this prior step and IDG's approach to minimizing demands on time from interlocutors.	May 5, 2021
51	VI.3.9	62	Odd reference to informing the EDR…this is the EDR	This was a tense issue. Revised	May 5, 2021
53	VI.6	63	For some of these indicators, it just says essentially that the value of the indicator will be calculated. Explain a little more what the analysis is.	Revised to reflect that these data will be used for HDM-4 analysis.	May 5, 2021
56	the KIIs in English	64	Maybe include a brief note explaining that while the Team Leader is a native Portuguese speaker, respondents voiced a preference for English.	Revised	May 5, 2021
59	VIII.1, "EQ 2C will be a pre-post performance evaluation to determine the effect of the CP on improving the road maintenance practices in Mozambique"	65	This isn't the evaluation question at all. This section needs to be revised, which references to a CP removed (the actual compact language isn't relevant here either, the question isn't asking about the effect of what we did do, but what we didn't)	Revised	May 5, 2021
59	VIII.1.2	66	This section is too vague	Revised	May 5, 2021
64	IX.5 - PTU	67	Why isn't this in EQ1? Shouldn't the value of time and the purpose of the trip of all road users be incorporated into the model estimating reductions in transportation costs?	Revised to include in EQ1 as well.	May 5, 2021
64	IX.5 - PTU	68	What is the most recent traffic count? How many buses?	Table added	May 5, 2021
64	IX.5.2 "The goal is to obtain a representative sample with sufficient power to generate statistically significant results'	69	I agree that the goal is a representative sample, but what do you mean by "sufficient power to generate statistically significant results"? What comparison are you making that requires statistical significance?	Revised	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
64	IX.5.4	70	Will passengers only be selected at the bus stations? Or also while on the busses? How will they be sampled at the station (this belongs in IX.5.7)? How will you choose the buses? How will you ensure all of this is representative?	We have simplified the approach and are assuming that passengers will be interviewed on buses. If this proves to be problematic, interviews at bus stations will be considered as an alternative.	May 5, 2021
65		71	Formatting is inconsistent on lots of these headers. No urgent changes needed, but just flagging	Revised	May 5, 2021
68	IX.10.1 "With this in mind, the O-D survey is also being supplemented by the Public Transport User survey which will serve as an additional data source for comparison purposes with and enrich the findings of the O-D survey."	72	How it is "supplemental" or a source for "comparison purposes"? What are those purposes? The PTU is really the same as the OD survey, but for a different sub-population…which makes it neither supplemental or a comparison I would think	Revised	May 5, 2021
69	X.4	73	The exposure period is the time from when the road was finished until today. It is not relevant for a baseline, unless the baseline is recording data for a time point after implementation, which is not the case here. I think you confuse it with "recall period" in this section.	Revised	May 5, 2021
71	X.8	74	traffic volumes and vehicle registrations aren't on the indicator list for this EQ	Section has been expanded. We consider traffic volume to be a key element of changes in traffic patterns (under 3B), since there is no baseline to compare with.	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
73	XI.5.3	75	Sample frame is missing, it just says it "will be drafted"	Because stakeholders will be selected using purposive sampling, and because the actual size of each stakeholder group is not known, and will not be a selection criterion, a quantitative sample frame is not available.	May 5, 2021
76	XI.8	76	This is basically a repeat of the evaluation question, please specify the analysis plan. It must specify how the associated quantitive indicators will be analyzed to reach the answer to the question.	Revised	May 5, 2021
77	Top of section XII.I	77	If at all possible, an HHS OHRP IRB in Mozambique would be especially helpful for local context and potential sensitivities. Not that this is a particularly sensitive survey, but still useful and best practice.	Revised to include this if possible	May 5, 2021
77	raw, de-identified	78	How will it be both raw and de-identified? Does this mean a public use and a restricted use, or just a raw, identified dataset? Maybe that's just a terminology thing, but MCC's nomenclature for these things is defined in the TREDD Guidelines	Removed submission of raw data based on TREDD guideline that holding such data is not MCC's practice.	May 5, 2021
General	General	79	For any data collection where you propose to re-collect data that was already collected by IMC, please provide the rationale in the EDR	Rationale for recollecting O-D survey data is that passenger vehicles were not included as part IMC survey, the sampling rate was low, and no PTU survey was conducted. Rationale for re-collection has been added throughout the report.	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
Budget	EQ 0 KIIS and review of secondary sources	80	Why was EQ0 not budgeted for at the proposal stage?	During the proposal stage, IDG did not include EQ0 in the budget for data collection on the assumption that the data from the previous contractor could be used. However, after receiving access to the data, IDG has proposed realigning its budget to reflect the LOE needed to obtain the information that could be used from the previous contractor, and conduct additional KIIs, in order to answer EQ0.	May 5, 2021
Budget	EQ 0 KIIS and review of secondary sources	81	Please rephrase the second sentence in the notes, I don't understand	The sentence has been revised to be clearer	May 5, 2021
Budget	General	82	This contract was signed in September 2020. Why did you assume that COVID precautions would not be necessary?	The procurement for this evaluation was conducted in July 2020, at a moment of significant day-to-day uncertainty about the long-term global operating context due to the pandemic. IDG did include COVID precautions in its approved work plan by anticipating virtual stakeholder meetings and KIIs until international travel would be possible. IDG will continue to coordinate closely with MCC to ensure its planning is in accordance with ethical and legal constraints to minimize the spread of infection.	May 5, 2021
Budget	EQ 1 VOC Survey	83	We can't justify spending this much (either the revised or the original) for 15 interviews. Please recommend an approach that optimizes between quality and cost.	The VOC survey will not be redone. IDG will use the data previously collected by IMC.	May 5, 2021
Budget	EQ 3A Travel Time Study	84	We can't justify spending this much for what is described in the EDR. Are you sure this is correct? Please recommend an approach that optimizes between quality and cost.	The budgeted amount includes the cost of a local subcontractor, as well as for labor and ODCs, to account for COVID precautions during data collection. The cost for the local subcontractor is based on best information currently available and in consultation with the local coordinator--	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
				actual costs will be dependent on quotes to be received from subcontractors during the procurement stage.	
Budget	EQ 3A Travel Time Study	85	What changed between the proposal and the EDR to necessitate the inclusion of this data source?	IDG did not know prior to receiving documents from IMC that a travel time study had not previously been done. The study is needed in order to answer the evaluation question.	May 5, 2021
General		86	Please recommend the best timing for data collection. The contract dates are not a constraint, so please recommend the best timing, optimizing between evaluation quality and cost.	IDG proposes data collection in November 2021, and has updated the report to include this proposal, including the Gantt chart in Annex II.	May 5, 2021
Evaluability Assessment		87	Please do not attach to public version of EDR	Noted	May 5, 2021
OD Survey Memo		88	Based on what you wrote, it seems re-doing the survey isn't really necessary for EQ1. The memo is a bit too light on the implications for EQ3, which is where it seems to matter most. How does the sample rate compare to IDG's recommended sample rate for a representative sample? The partial OD survey is an interesting option, thank you for proposing that and thinking outside the box. Of these options, please recommend to us what you think optimizes cost against quality.	We have removed this memo as a separate annex and included specific language describing the issues with the previous O-D survey and the justification for the proposed course of redoing the survey in Section V.4.	May 5, 2021
Annex III		89	Please include the baseline locations if different. Please include OD locations.	Map has been updated to include this detail	May 5, 2021
Annex V		90	I had some momentary confusion seeing Annex II (Fatigue), immediately followed by Annex IV (not part of the HDM-4 Calibration Report). Not crucial to change, but clarifying would be helpful.	Revised	May 5, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
4	II.I.3.1 and Table II.1	91	The report still states that the data source is the Compact Completion Report, but the Closeout ITT is the official data. Please use the ITT data and not CCR data throughout the report, not just here.	This has been corrected in the report and in the comment response above.	Oct. 15, 2021
8	II.3.2, Comment #17	92	It's not clear to me here, or throughout the report, which HDM-IV files you have and can run, and which you cannot/do not have. I see references to the ex-ante ERR and the post-Compact ERR but believe there were work files for the rescoping ERR as well. Please be explicit about which you do/do not have and can/cannot run.	To clarify: The HDM-IV Specialist reports that all of the necessary inputs files are present to generate the models. The models shared run successfully when loaded but attempting to view the output generates an error. Despite this, the team is able to build the models needed using the input files and obtain the results that way.	Oct. 15, 2021
	Comment #9	93	Confusing wording on your explanation: you're not supposed to use data from the Compact Completion Report but are saying it is from p. 80 of that report. Please cite the ITT	This has been corrected in the report and in the comment response above.	Oct. 15, 2021
	Comment #11	94	The Compact Completion Report is not a valid source for data or official figures. Do not cite in that context.	This has been corrected in the report and in the comment response above.	Oct. 15, 2021
	Comment #12	95	I don't see the new table that the Comments Matrix says was produced for the report. Please revise or otherwise address the original comment.	The paragraphs in question have been edited in response to the original comment (#12).	Oct. 15, 2021
21, 28	III.2 Table 2 & Table 3	96	Per the common indicator guidance on IRI, MCC is ok with a Class 3 device and only requires one section be repeatable. MCC's other evaluations have also used 100m increments, so switching to a significantly higher cost method must be justified explicitly. There is a validation worksheet which we can pass along if IDG does not have the document.	Regarding repeatability, reliable calibration requires repeated measurements on at least six control (or calibration) sections. Regarding Class 1 vs Class 3 device roughness measuring devices, we suggest in consultation with the evaluation's HDM-IV Specialist that the cost of using a portable laser profiler (Class 1) as for other recent evaluations would be closely comparable to the cost of a Class 3 device. One solution may be including the use of both classes in the ToR and select the most	Oct. 15, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
				cost-efficient approach that can deliver the necessary results. The EDR has been revised to reflect 100m increments as requested.	
26+	Comment #37, III.2 Table 3	97	The MCC Common Indicators are copied here, but in name only. Please use the full indicator, including unit, definition, and the relevant details.	The definitions have been revised to include detail from the common indicators.	Oct. 15, 2021
	Comment #47	98	I don't see the EQ referenced in this section. Please revise	The text has been revised to reflect the evaluation question more explicitly.	Oct. 15, 2021
47	Comment #55	99	Response is not clear	The text was cut off in the comment sheet previously but has been restored above.	Oct. 15, 2021
	Comment #61	100	Both in the budget and the report, it still seems like we are going to be re-doing a considerable number of KIIs. What's the issue with the IMC KIIs? Please justify re-collecting the data, likely from the same respondents. Methodological concerns? Something else? Otherwise, I don't see a great need to re-produce that data.	Text has been added to the document with an explanation of the need to conduct KIIs.	Oct. 15, 2021
	IV.4 - Table 4	101	Thank you for showing the correct exposure period. However it should still be expressed in months/years rather than "Dec 2013 to present". More broadly about exposure periods, there are many that list 7.5 years and several that list 8.5 years. Please clarify	Revised	Oct. 15, 2021
42	with evaluators either traveling on the bus and/or interviewing passengers at bus stations	102	I think you mean enumerators here rather than evaluators if it is to be sub-contracted	Revised	Oct. 15, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
34, 54, 59	KIIs	103	This is acceptable since review of the IMC interviews should be very instructive when deciding who to interview. However, please ensure that you share the list of interviewees with us with a rationale, so we make sure we're not creating too many redundancies. We also assume that the budget estimate is the highest possible, but please let us know if that is incorrect.	The text has been revised to reflect these concerns. The statement about the budget estimate is correct.	Oct. 15, 2021
42, 67	Origin-Destination Survey	104	We looked back at the IMC data as part of the review and left it needing some clarifications. Please review the file "Mozambique_Roads_Evaluation_v7_data.csv", using the key in "Mozambique_Roads_Evaluation O-D Survey Form_v7.xlsx". To our eye, there are a few cars registered, but possibly by accident. There are lots of quality issues in it so we suspect that the full re-do is required, but please confirm in the data.	It is indeed correct that there a small number (12 to be exact) of personal cars that were included in the survey. They are found under “other” as pessoal, or carro pessoal. This seems to be an error on the part of IMC's data collectors, who were apparently instructed to not include this vehicle category in the O-D survey, for reasons not explained in IMC documentation.	Oct. 15, 2021
70	Travel Time Study	105	Why would the labor estimate mimic that of the PTU - they are very different surveys and should require very different levels of effort.	The amount budgeted is an estimate at the high end of the possible cost but it has been revised, and the reference to labor requirements relative to the PTU has been removed.	Oct. 15, 2021
General/ Budget		106	There are two data collection budget lines that concern me. The first is the KII cost, already mentioned in an above comment. Justification is needed for re-collecting data already collected by IMC. The other one is the Travel Time survey, which has a price tag considerably above any of our other travel time studies, even on a per km basis. It is 253km of road and was previously took just two days to do. $83,000 just feels like a significant misestimation of costs even with a sub-contractor and, if it isn't one, may be a	Justification for the KIIs proposes is included in the response to comment #100 and the text in that section of the report has been revised. The cost of the Travel Time Study has also been revised in response to comment #105.	Oct. 15, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
			miscalibration of cost vs learning. Please revisit this estimate and make sure it is the optimal balance of resources being committed.		
55	Summer 2022	107	Very minor, but if we're using "July 2022" throughout, please use it here as well.	Revised	Oct. 15, 2021
86	Report writing timeline	108	For the final version of the EDR, please push the report writing and finalization out to whatever level you actually expect it to take without much concern for the	The report writing timeline has been revised accordingly.	Jan. 6, 2022
STAKEHOLDER COMMENTS					
2	The Compact originally called for the Roads Project to rehabilitate 491 kilometers of high priority roads spread across three northern provinces. However, in 2011, the Compact ultimately approved the rehabilitation of two primary Estrada Nacional/National Route 1 (N1) road segments.	1	**We sugest the following correction:** However the compact ultimately approved the rehabilitation of two segments of the primary National Road 1 (N1) or where it reads "…Compact ultimately approved…" could be replaced by "As result of increase in construction cost the Compact was re-scoped to the reahabilitation of two “primary ..."	Revised as suggested	Mar 24, 2021
5	By 2028, nearly 1.2 million beneficiaries in districts adjoining the N1 roads in Nampula would have benefitted from the rehabilitation	2	**On page 10 we have different figure as indicated below:** At Compact signing, the number of potential beneficiaries in districts adjoining the roads, with improved access was estimated to be 2.3 million by 2015	The context and basis for the estimation of beneficiaries has been more clearly explained.	Mar 24, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
8	The ERRs reported in the IM for the two roads that were rehabilitated are 8.4% for the Namialo - Rio Lurio section and 8.8% for the Nampula - Rio Ligonha section.	3	There is a difference between the original ERR's indicated in this paragraph with the 2009 original ERRs indicated in the table of page 9.	The section has been revised for consistency.	Mar 24, 2021
10	More than 60% of the beneficiaries are in Nampula. However, MCC's Principles into Practice refutes this theory and suggests that road project beneficiaries should be defined as road users and not those living near the improved road segment.	4	considering that the MCC's Principles into Practices were published in 2017 and the Compact assumptions were adopted in 2007, how useful ares those principles to assess the Compact results. The new criteria could not be comparable with the expected result from the Compact	The context and basis for the estimation of beneficiaries has been more clearly explained.	Mar 24, 2021
37	The evaluation team will allow bidders to consider conducting the traffic counts with teams of five enumerators (two for each direction and one enumerator to support both directions) taking six- or eight-hour shifts to be cost effective. One supervisor will be responsible for each team of enumerators	5	What will be the role of the one enumerator supporting both direction?	The floating enumerator will provide support during breaks for those on both sides.	Mar 24, 2021
39	The O-D survey will be conducted one time (date to be determined) The survey will be	6	Please clarify how many days the survey will be conducted.	The text has been revised to correct this error.	Mar 24, 2021

Page	Text	Comment #	Comment	IDG Response	Comment date
	conducted for **three (2)** days of 24 hours covering representative days of the week (based on AADT for the location)				

ANNEX III: EVALUATION WORK PLAN

Updated Jan 28, 2022

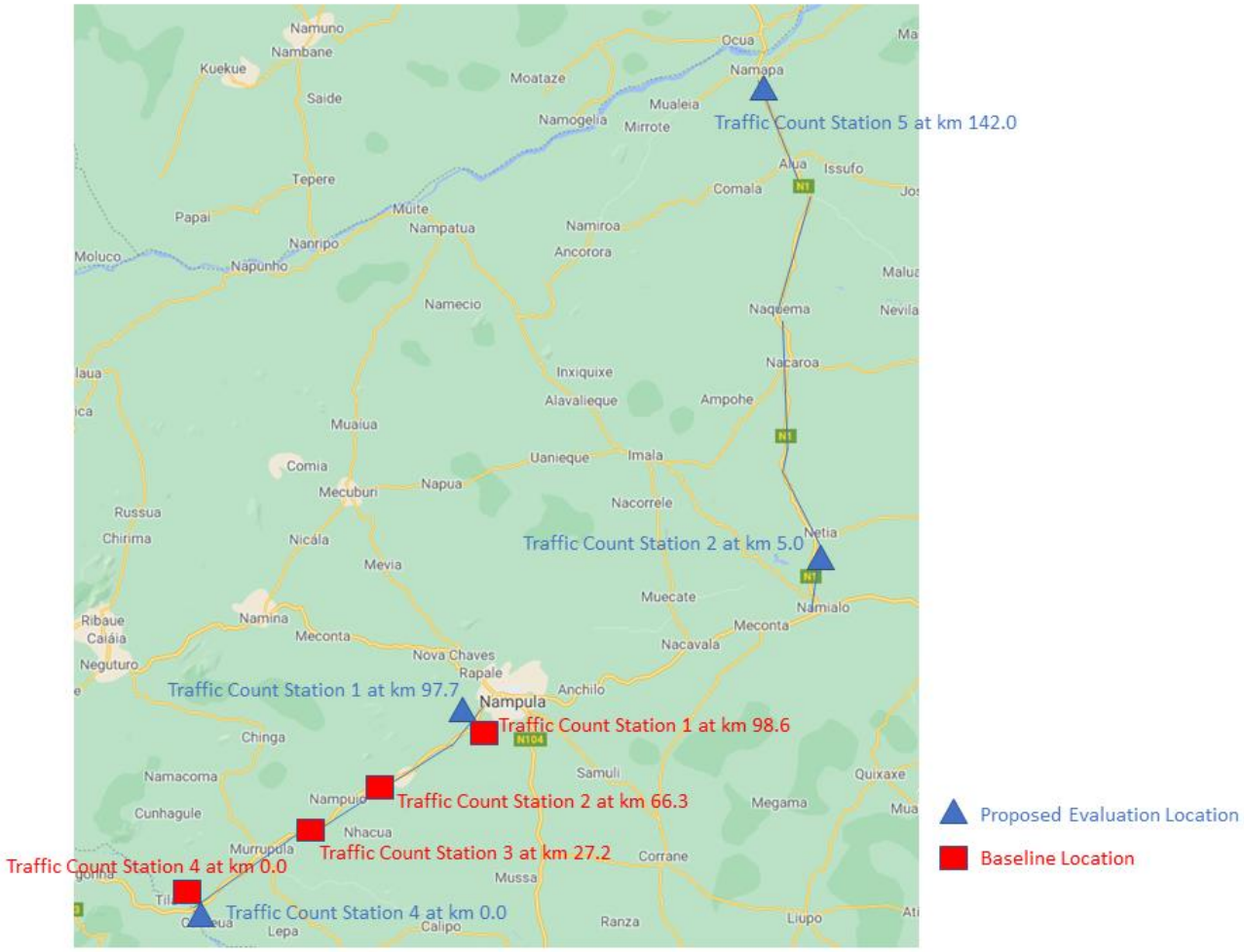
Activity	Responsibility*	Work Plan
Rapid Start-up and Reporting		
Submit Monthly Progress Report	CM, HO	
Phase I - Base Period (Evaluation Design)		
Task 2: Develop Evaluation Design Report		
Develop and refine the EDR through a collaborative process with MCC and local stakeholders. IDG used as a starting point the previously approved EDR.	TL, HS, RE, EE, IC, JA	
Share Portuguese translation of Executive Summary with stakeholders to ensure their comments were adequately addressed	TL, HS, RE, EE, IC, JA	
Make PDFs of Final EDR and Portuguese Executive Summaries 508-Compliant	JA	
Submit Final Evaluation Design Report, including Evaluability Assessment and summary of MCC and local stakeholder feedback as Annexes, as well as final Executive Summaries in Portuguese and English	TL, CM, JA	
Submit Nesstar Metadata for Evaluation Catalog entry	TL, CM, JA	
Evaluation Design published		
Task 3: Revise or Develop Endline Evaluation Materials		
Revise the Evaluation Design Report (as needed) as evaluation develops	TL, HS, RE, EE, IC, JA	
Identify local data collection firms	IC	
Develop a data extraction approach for existing data sources to be used	TL, HS, RE, EE, IC, JA	
Draft and submit data collection firm terms of reference	TL, HS, RE, EE, IC, JA	
Draft and submit draft survey questionnaires, data collection manuals, and other data collection instruments/protocols	TL, HS, RE, EE, IC, JA	
Incorporate feedback from MCC on first draft of evaluation materials	TL, HS, RE, EE, IC, JA	
Conduct a virtual review of data collection questionnaires, data collection manuals, and other instruments and protocols with local stakeholders	TL, IC	
Incorporate feedback from MCC and local stakeholders and revise evaluation materials	TL, HS, RE, EE, IC, JA	
Submit draft RFP to MCC for approval before releasing RFP for data collection firms	CM, HO	
Submit in-person data collection risk assessment and mitigation form and get MCC approval	TL, CM, HO	
Solicit responses (RFP) from data collection firms and select a firm	TL, CM, HO	
Submit consent to subcontract for chosen data collection firm(s) to MCC and receive MCC approval	TL, CM, HO	
Submit IRB package including evaluation protocol, informed consent statements, in-person data collection risk assessment and mitigation form + MCC approval, and other documents and approvals	TL, CM	
Submit summary of written review of back-translation	TL, CM	
Sign subcontract with chosen data collection firm(s)	TL, CM	
Submit final versions of data collection questionnaires and training manuals in Portuguese and English	TL, CM	

Updated Jan 28, 2022

Activity	Responsibility*	Work Plan
		Y1: Sept 2020 - Oct 2021
		Y2 - Q5: Nov. 2021 (1, 8, 15, 22, 29) · Dec. 2021 (6, 13, 20, 27)
		Y2 - Q6: Jan. 2022 (3, 10, 17, 24, 31) · Feb. 2022 (7, 14, 21, 28) · March 2022 (7, 14, 21, 28)
		Y2 - Q7: April 2022 (4, 11, 18, 25) · May 2022 (2, 9, 16, 23, 30) · June 2022 (6, 13, 20, 27)
		Y2 - Q8: July 2022 (4, 11, 18, 25) · Aug. 2022 (1, 8, 15, 22, 29) · Sept. 2022 (5, 12, 19, 26)
		Y3 - Q9: Oct. 2022 (3, 10, 18, 24) · Nov. 2022 (31, 7, 14, 21, 28) · Dec. 2022 (5, 12, 19, 26)
		Y3 - Qs 10-12: Q 10 · Q 11 · Q 12
Task 4: Undertake Data Collection		
Submit SOW, Trip Report for country visit including written minutes of meetings with data collection firms	TL, HO	
Summary of pre-test conducted by data collection firm	TL, HO	
Revise/update evaluation materials during data collection	TL, HS, RE, EE, IC, JA	
Train data collection firm staff	TL, HS, RE, EE, IC, JA	
Conduct pilot tests for all data collection methods and submit summary of enumerator training and pilot test	TL, HS, RE, EE, IC, JA	
Collect data and conduct field visits, quality assurance and quality control	TL, HS, RE, EE, IC, JA	
Monitor data for quality control and process data entry	TL, HS, RE, EE, IC, JA	
Submit IRI Precision and Bias Report at the start of IRI data collection	TL, RE	
Submit Data Collection Report summarizing results, response rate, data collection implementation efforts, challenges encounters, and data quality control checks conducted	TL, CM, HO	
Submit revised Phase II budget for MCC approval/technical directive	TL, CM, HO	
Phase II - Option Period I		
Task 5: Develop Final Report and Data Documentation Package		
Submit first draft of Evaluation Report in English, with Executive Summary in English, to MCC	TL, HS, RE, EE, IC, JA	
Draft and Submit Data Package as per MCC TREDD Guidelines (questionnaire(s), informed consent(s), Data Package Worksheet, public-use and/or restricted-access microdata package, HDM-4 files, and analysis code)	TL, HS, RE, EE, IC, JA	
Implement MCC's feedback and submit second draft of Evaluation Report to MCC	TL, HS, RE, EE, IC, JA	
Share Evaluation Report Executive Summary translated into Portuguese with local stakeholders	TL, HS, RE, EE, IC, JA	
Submit Evaluation Brief content	TL, HS, RE, EE, IC, JA	
Submit draft of Evaluation Report for local stakeholder review and implement feedback	TL, HS, RE, EE, IC, JA	
Submit Data Collection Inventory with summary data and analysis	TL, JA	
Submit publicly accessible visual images of the current road condition	TL, SS, JA	
Submit Final Evaluation Brief	TL, HS, RE, EE, IC, JA	
Submit Final Evaluation Report including Public Statements of Difference/Support in English/Portuguese	TL, CM	
Final Report and Executive Summary in Portuguese published		
Final data package published		
Task 6: Disseminate Final Results		
Submit SOW, Trip Report for each country visit	TL, HO	
Present results of the Final Evaluation Report findings at MCC headquarters and to other local stakeholders	TL, HS, IC	
Submit presentation materials and update Nesstar Metadata as appropriate	TL, CM	
Participate in other MCC-financed dissemination and training events	TL, HS, JA	
Deliver entire contents of the project library in digital and paper copy for public distribution	TL, JA	

ANNEX IV: MAPS OF ROADS TO BE EVALUATED, TRAFFIC COUNT & O-D SURVEY LOCATIONS

Figure 6 Proposed O-D survey collection sites and baseline collection sites



ANNEX V: BUDGET

Budget is included as a separate Excel attachment.

Budget Narrative (Internal)

When MCC re-issued the contract for the Mozambique RRP Evaluation, MCC limited the procurement to 1 million USD. At the time that IDG submitted its proposal (2020), IDG did not anticipate that this evaluation could be completed within the confines of 1 million dollars. Even IDG's final cost proposal, which MCC ultimately accepted, contained a tight budget with several estimates for in-country data collection that were intended to be verified during the evaluation team's first trip to Mozambique.

This scoping visit to Mozambique, which was intended to inform the evaluation design and gain an understanding of the capabilities of data collection firms in Mozambique and/or neighboring countries, was not possible due to travel restrictions resulting from the global COVID-19 pandemic. IDG anticipated this possibility by planning for virtual stakeholder meetings and KIIs if necessary in its work plan, and successfully incorporated these inputs into this design report. The extent to which data collection firms are able to operate within Mozambique, as well as any associated increase in costs resulting from enhanced safety and security measures, is still unknown.

As presented in our evaluation design, IDG proposes using existing survey data for axle load, geotechnical survey, and deflection measurements, and will therefore not conduct these three studies. Additionally, an observation of the road condition will be conducted during the road roughness study in lieu of conducting a detailed road condition study.

While we do propose several in-person data collection activities, as part of our risk mitigation plan we will conduct all KIIs remotely, rather than in person. Based on our experience conducting remote data collection for another MCC Road Evaluation, remote data collection takes significantly more time which requires additional LOE. As a result, we have increased the budget line items for the KIIs accordingly.

In the attached budget, IDG has submitted estimates in line with the appropriate reductions in the proposed data collection. However, given the inability to verify our estimates for in-country data collection and the increased costs associated with both in-person data collection and remote data collection as a consequence of the COVID-19 pandemic, it is likely that we will still need to expend the full amount, or very close to the full amount, of the budget. The estimated cost for the evaluation is therefore close to the contract ceiling.

ANNEX VI: HDM-4 LEVEL I CALIBRATION REPORT

Level I Highway Development and Management-4 (HDM-4) Model Calibration Report

Mozambique Roads Rehabilitation Project Evaluation

I. INTRODUCTION

OVERVIEW

The Millennium Challenge Corporation (MCC) and the Government of Mozambique (GOM) signed a Compact on July 13, 2007, which ended on January 20, 2014, for US$ 506.9 million. The Compact goal was to reduce poverty through economic growth in the four Northern provinces of Mozambique: Niassa, Cabo Delgado, Nampula, and Zambezia. The Compact listed four primary objectives that were implemented via four distinct projects: 1) Increase access to reliable sources of potable water supply and improved sanitation facilities, 2) Increase access to productive resources and markets while reducing transport costs, 3) Establish efficient and secure land access for households, communities, and investors, and 4) Protect and restore healthy coconut supply, and diversity farmers' income. The Roads Rehabilitation Project pertains to Objective 2 and had a budget of $176.3 million.

On September 25, 2020, MCC issued a contract to International Development Group LLC (IDG) to conduct an Economic Analysis and Independent Evaluation Services in support of the Mozambique RRP. The evaluation, designed to understand the impact of the RRP on Mozambique's economic growth, is mainly threefold: 1) a review of the activity implementation (Evaluation Area 0) to identify any deviations from the original design, 2) an economic analysis (Evaluation Area 1) to understand the costs and benefits of the MCC-funded road, and 3) performance evaluations of road maintenance, road usage patterns, and transport market structure to complement and enhance knowledge gained through the economic analysis (Evaluation Areas 2, 3, and 4).

The economic analysis portion of the services will be conducted using the Highway Development and Management (HDM-4) model, originally developed by the World Bank. The MCC requirement include Level 1 calibration of the HDM-4 model. This report presents the approach to Level 1 calibration of the HDM-4 model to be used and includes available data and identify the input data to be updated. The Level 1 calibration requires additional data collection during the data collection phase and the Evaluation Team will update the level 1 HDM-4 parameters from this report based on data collection for the final HDM-4 analysis.

INTRODUCTION TO HDM-4

HDM is essentially an analytical tool for engineering and economic assessment of:

- road investment and maintenance strategies
- viability of road investments in terms of savings in vehicle operating, time and road maintenance costs
- transport pricing and regulation
- network program optimization
- budget strategy analysis

HDM is based on physical and economic relationships derived from research in road deterioration, mainly resulting from traffic volumes and characteristics (such as axle loadings), environment and the effects of maintenance activities. In its core, HDM-4 economic analysis is a cost-benefit analysis; it compares the cost streams for the existing "without-project" situation and the proposed "with-project" road upgrading or improvement situation.

HDM operates in three phases:

- calibration, data input and diagnostics phase, in which input data are generated and examined;
- simulation phase, in which traffic flows and changes in road conditions from initial construction through annual cycles of use, deterioration and maintenance are analyzed; and
- economic analysis and comparison phase, during which alternative construction and maintenance policies are analyzed and compared to the base case for selected groups and road links

HDM computes:

- deterioration of paved and unpaved roads for a set of specified road agency strategies;
- road user costs as a function of the roadway and vehicle characteristics; and
- time-streams of road agency and user costs for the specified strategies

It compares these strategies by presenting relevant economic indicators such as economic rate of return, net present value and benefit cost ratio.

The HDM analysis is carried out over engineering design life of the road project and considers all quantifiable costs and benefits to the road agency and road users. The road agency cost includes primarily the road construction and maintenance costs. The road user costs include vehicle operation cost, travel time, cost of road crashes, and environmental cost of vehicle emissions etc. The cost streams for road agency and road users will be generated for each project options included in the analysis and the cost and benefit streams for the project option will be generated to calculate the economic indicators.

HDM-4 Calibration

Since HDM model simulates future changes to the road system from current conditions, the reliability of the results is dependent upon two primary considerations:

1. How well the **data** provided to the model represent the reality of current conditions and influencing factors, in the terms understood by the model; and
2. How well the **predictions** of the model fit the real behavior and the interactions between various factors for the variety of conditions to which it is applied.

Application of the model thus involves two important steps:

- *Data input* – Interpreting the data input requirements correctly and obtaining input data of appropriate quality for the desired reliability of the results. This consists of determining parameters that describe the physical characteristics of the pavements, road user data, traffic data, unit costs, and economic data.
- *Calibration of outputs* - Adjusting the model parameters to enhance how well the forecast and outputs represent the changes and influences over time and under various interventions.

Calibration differs from input data since calibration is aimed at adjusting the model predictions. In particular, the two primary sub-models that determine the future trend of the physical quantities, costs, and benefits for the analysis are:

- *Road User Effects* **(RUE)** including vehicle operating costs (VOC), travel time, safety, and emissions; and

- *Road deterioration and works effects* **(RDWE)** including deterioration of the pavement, the impact of maintenance activities on pavement condition, and the future rate of pavement deterioration.

There are three levels of HDM-4 calibration which require low, moderate and high-level effort and resources respectively depending on its level of rigor:

1) **Level 1 - Basic Application**

   Determines the values of required basic input parameters, adopts many default values, and calibrates the most sensitive parameters with best estimates, desk studies or minimal field surveys.

2) **Level 2 - Calibration**

   Requires measurement of additional input parameters and moderate field surveys to calibrate key predictive relationships to local conditions. This level may entail slight modification of the model source code.

3) **Level 3 - Adaptation**

   Requires major field surveys and controlled experiments to enhance the existing predictive relationships or to develop new and locally specific relationships for substitution in the source code of the model.

Level 1 is the specified calibration level for the Mozambique road evaluation. For the current evaluation a Level 1 calibration will be undertaken as described in this report.

Level 1 Calibration

A Level 1 calibration will be primarily based on secondary sources (i.e. desk study), such as government and industry publications, operator organizations, or data from previous HDM/economic analyses conducted in Mozambique for similar road investment projects or HDM-4 calibration data available with ANE. Moreover, as recommended by the publication "HDM-4 A Guide to Calibration and Application", it will be assumed that the bulk of the default HDM parameters are appropriate for local conditions in Mozambique and that only the most critical ones need further examination.

Besides adopting many of HDM's default values, Level 1 calibration determines the values of the model's basic input parameters with respect to the key variables within each of the following HDM-4 modules: **Road Network**, **Vehicle Fleet,** and **Road Works (**summarized in Section VII of this report**)**. The HDM-4 model with level 1 calibration will be run for the project road and model predictions of distress will be compared with observed distress and distress predicted from fatigue curves (Section IX of this report) and calibration factors will be modified iteratively as needed to make the HDM-4 model predictions as reasonable as possible. It can be summarized that the following categories of data, which relate to the three HDM-4 modules, will need to be defined for a Level 1 calibration:

- Road characteristics and pavement condition;
- Vehicle fleet characteristic data and unit costs;
- Traffic characteristics and growth rates;
- Regional climatic type;
- Road works data and unit costs (i.e. improvement and maintenance works); and

- Economic analysis data (i.e. discount rates and analysis period).

The objective of this Level 1 HDM-4 Calibration Report is to present a reliable starting point for applying the HDM-4 model for the economic evaluation of the RRP. The report will discuss and present data and sources to be used within the above categories as recommended for a Level 1 calibration. The data obtained from MCC and secondary sources during the team visit in February 2020 are given and additional data to be collected are indicated.

II. ROAD CHARACTERISTICS CALIBRATION

KEY PARAMETERS

In the Road Network module of HDM-4, the existing functional, physical, geometric and structural engineering characteristics of the road sections under RRP (i.e. Namialo/ Nampula), prior to the investment, are to be defined and will be used in modeling the road performance without the project improvement. Prior to the project investment, the two road sections were paved road in mostly good to poor condition with an overall average IRI of 4.0m/km for Rio Ligonha to Nampula Road and 3.7m/km for Namialo - Rio Lurio Road. The data input required to define the physical road characteristics and pavement conditions of the project road include road characteristics (length, carriageway width, shoulder width, geometric features, traffic level) and pavement characteristics (type, composition, construction history, strength and pavement condition).

DATA AND SOURCES FOR CALIBRATION

The project feasibility study and design report[71] provide most of the details required for the road characteristics calibration. The Namialo - Rio Lurio Road was constructed in the mid 1960's. The original construction time of Rio Ligonha to Nampula Road is not reported but is likely to be during the same time or earlier. The roads have generally good geometry.

The proposed rehabilitation under the Compact as per feasibility study included widening to standard two-lane width with paved shoulders and reconstruction of the pavement.

The feasibility study and detailed design as well as subsequent MCC analysis during re-scoping and close out used HDM 4 for the economic analysis and several of the model input data is available in the HDM models shared by MCC. The data for the base road network module ("without project" case) was therefore derived from road details given in the project design report and the HDM-4 model shared. Table 12 presents a set of values for the road characteristics and condition parameters and the sources for each value. The data for the road sections after project investment was derived from the as-built drawings obtained from ANE. For data which are currently not available or not feasible to obtain, HDM-4 default values are used.

[71] (1) Feasibility Study, Environmental and Social Impact Assessments, Design and Supervision of Works for Rio Ligonha to Nampula Road – Phase 2: Detailed Design – Volume – 2: Main Report, SMEC, October 2010; (2) Final Detailed Engineering Design Report –Revision 1: VOLUME 2: MAIN REPORT – PART A: ROADWORKS, Scott Wilson Ltd., Feb 2011

Table 12: Road Network Characteristic Data for the Rio Ligonha to Nampula Road

Type	Road Parameter	Unit	Without Project	With Project
Definition	Length	km	102.84 (3 homogenous sections of 66, 32 and 4.84 km)	102.84 (3 homogenous sections of 66, 32 and 4.84 km)
	Carriageway width	m	6.5, 6.5, 14.0	6.8, 6.8, 14.0
	Shoulder width	m	1.5	1.5
	Number of lanes		2,2,4	2,2,4
Geometry	Rise and fall	m/km	22.7, 23.7, 5.7	22.7, 23.7, 5.7
	Horizontal curvature	deg/km	12.4, 15.1, 17.5	12.4, 15.1, 17.5
	Speed limit	kph	100	100
	Altitude	m	400	
Pavement	Pavement type		Surface treatment	Surface treatment
	Subgrade material		silty or clayey gravel and sand	
	Current surfacing thickness	mm	30	25
	Construction year		1979	2013
	Last rehabilitation year		1979	Not applicable
	Last surfacing year		1979	Not applicable
	Base type		Granular	Cement modified base
	Last preventive treatment year		2007	Not applicable
	Number of rise and falls	Per km	0.84, 1.0, 4.5	0.84, 1.0, 4.5
	Super elevation	%	2	2
	Acceleration noise	m/s^2	0.1	0.1
	Speed reduction factors		1	1

Table 13: Road Network Characteristic Data for the Namialo to Rio Lurio Road

Type	Road Parameter	Unit	Without Project	With Project
Definition	Length	km	149.7 (3 homogenous sections of 67.1, 55.6 and 27 km)	149.7 (3 homogenous sections of 67.1, 55.6 and 27 km)
	Carriageway width	m	5.8	6.8

Type	Road Parameter	Unit	Without Project	With Project
	Shoulder width	m	1.5	1.5
	Number of lanes		2	2
Geometry	Rise and fall	m/km	17.8, 22.3, 21.7	17.8, 22.3, 21.7
	Horizontal curvature	deg/km	18.7, 19.3, 9.5	18.7, 19.3, 9.5
	Speed limit	kph	100	100
	Altitude	m	275	
Pavement	Pavement type		Surface treatment	Surface treatment
	Subgrade material		silty or clayey gravel and sand	
	Current surfacing thickness	mm	25	25
	Construction year		1965	2013
	Last rehabilitation year		2003	Not applicable
	Last surfacing year		2003	Not applicable
	Base type		Granular	Crushed stone base
	Last preventive treatment year		2009	Not applicable
	Number of rise and falls	Per km	0.64, 1.1, 0.75	0.64, 1.1, 0.75
	Super elevation	%	2	2
	Acceleration noise	m/s^2	0.1	0.1
	Speed reduction factors		0.85	1

III. VEHICLE FLEET CHARACTERISTICS AND UNIT COSTS

KEY PARAMETERS

In the Vehicle Fleet module of HDM-4, the characteristics and price/cost values of the vehicle fleet to be used in the analysis together with the traffic growth sets for each of the vehicle classes must be defined. Setting up the Vehicle Fleet module involves defining the following key parameter groups: i) vehicle categories and representative vehicle models; ii) vehicle characteristics and operating costs; and iii) value of time.

Vehicle Categories

The modelling of vehicle fleets in HDM-4 is done through defining a set of vehicle categories that reflect the actual traffic composition being evaluated. HDM-4 includes 20 default vehicle types, for which the models for vehicle speed, road user effects, and social and environmental effects have been developed. The default vehicle types fall into the following two categories:

1) Motorized Vehicles: motorcycle, car (small/ medium/ large), light delivery vehicle, light goods vehicle, four-wheel drive, truck (light/ medium/ heavy/ articulated), bus (mini/ light/ medium/ heavy), and coach.
2) Non-motorized Vehicles: pedestrian, bicycle, rickshaw, and animal cart.

Vehicle Characteristics and Operating Costs

Representative Vehicle Models. As the modelling of each individual vehicle is impossible, each vehicle category defined will be represented by a representative vehicle model. The technical, operational and economic characteristics of the representative vehicle model will represent that of the entire vehicle category. Based on the selected representative vehicle models, the technical, operational and economic characteristics of each representative vehicle model in the vehicle fleet will be defined. The data input required to define characteristics and operating costs of each representative vehicle model include, but are not limited to, the following:

Table 14: List of Key Vehicle Characteristics and Operating Costs Parameters

Parameter	Unit
Economic Unit Costs	
New vehicle cost	$/vehicle
Fuel cost	$/liter
Lubricant cost	$/liter
New tire cost	$/liter
Maintenance labor cost	$/hour
Crew cost	$/hour
Tire retread cost	%
Overheads (3rd party insurance)	$
Annual interest	%
Utilization and Loading	
Kilometers driver per year	Km
Hours driver per year	Hour
No. of axles	
No. of wheels	
Service life	Years
Passenger car space equivalent	PCSE
Percent time for private use	%
No. of passengers	
Work related passenger trips	%
Operating weight	Tons

Value of Time

Passenger Travel Time. Savings in travel time is an important benefit in road rehabilitation. To model this in HDM-4, the value of passenger travel time will need to be defined for each vehicle category while also differentiating between work and non-work times.

Cargo Delay. Cargo delay cost refers to the number of vehicle-hours spent in transit. Improved roads increase the travel distance of cargos within the same amount of time, thereby reducing the cargo delay cost. If applicable, the value of time for cargo delay will also need to be defined for each freight vehicle category.

INDICATIVE DATA AND SOURCES FOR CALIBRATION

The following sections present an indicative set of values for the above vehicle fleet characteristics and unit cost parameters.

Data collection activities will be conducted during the Base Period. After data collection has been completed, the precise values of the various vehicle characteristic parameters, calibrated to the Mozambique vehicle fleet, will be finalized.

III.1.1 Vehicle Categories

The vehicle categories used by ANE and feasibility study were reviewed. The vehicle categories recommended to be adopted for the evaluation is given in Table 15. This will be reconfirmed based on the results of the pilot traffic volume surveys to ensure the closest possible representation of actual traffic composition.

Table 15: Vehicle Categories

Sl. No	Vehicle Category	Description of vehicle
1	Car	Small and medium passenger cars
2	Passenger Utility	Private passenger SUV and r vans
3	Microbus	Small bus used for public transport (up to 15 seats)
4	Medium bus	Medium bus (usually 4 tires) (15 to 21 passengers)
5	Large Bus	multi-axle or large two-axle bus
6	Light goods vehicle	Public Utility Vans and Cargo vehicles
7	2-axle Rigid Truck	medium two-axle rigid truck (> 3.5 tons)
8	3- and 4- axle Truck	Multi-axle rigid truck or truck with trailer
9	Trucks and Trailer	Truck with trailer (>4 axles)
10	Articulated Trucks	Articulated truck (5 or more axles)
11	Motorcycle	motorcycle or scooter
12	Non-motorized vehicles	Cycles or carts

III.1.2 Vehicle Characteristics and Operating Costs

The vehicle operating cost input data and vehicle utilization data from the project feasibility study are presented in Table 16 and Table 17. These data will be updated based on Origin-Destination survey (e.g. occupancy and trip purpose), axle load data from ANE (equivalent standard axle load factor (ESLAF)), vehicle operating cost data (prices of vehicles, tires, fuel, crew, maintenance labor etc.) from ANE.

III.1.3 Desired Speed

The HDM model shall be run on the road section with average characteristics reflecting the conditions for the average speed estimates. The predicted free speed shall be compared to the average speed estimate and the value for VDESIR used in the modelling adjusted by the ratio of the predicted speed to the estimated speed. After several runs of the model the predicted and estimated speeds should be the same.

Table 16: Vehicle Operating Cost Data (2009) used in Feasibility Study

Vehicle Name	Vehicle	Tire	Fuel (per liter)	Oil (per liter)	Maintenance Labor (per hour)	Crew (per hour)	Annual Overhead	Interest rate (%)	Value of Work time	Value of non-work time	Value of Cargo time
Very Heavy Goods Vehicles	$259,780.00	$307.00	$0.64	$3.47	$3.30	$2.46	$2,537.00	$6.20	$0.45	$0.14	1
Motorcycles	$870.00	$10.00	$0.39	$2.30	$2.86	$0.39	$100.00	$5.00	$0.29	$0.09	0
4 wheel drive	$42,425.00	$83.90	$0.64	$3.47	$3.30	$0.43	$655.00	$6.20	$0.45	$0.14	1
Pickup 4x2	$29,242.00	$83.90	$0.64	$3.47	$3.30	$0.43	$655.00	$6.20	$0.45	$0.14	1
HGV, trucks greater than 3.5Tons	$98,719.00	$307.00	$0.64	$3.47	$3.30	$2.46	$1,962.00	$6.20	$0.45	$0.14	1
Light bus	$47,630.00	$83.90	$0.64	$3.47	$3.30	$2.01	$1,277.00	$6.20	$0.45	$0.14	0
Medium Car	$24,191.00	$60.63	$0.64	$3.47	$3.30	$0.43	$655.00	$6.20	$0.45	$0.14	0
MGV, trucks greater than 3.5Tons	$71,709.00	$163.60	$0.64	$3.47	$3.30	$2.10	$1,243.00	$6.20	$0.45	$0.14	1

Vehicle Name	Vehicle	Tire	Fuel (per liter)	Oil (per liter)	Maintenance Labor (per hour)	Crew (per hour)	Annual Overhead	Interest rate (%)	Value of Work time	Value of non-work time	Value of Cargo time
Very Heavy Goods Vehicles -Full Trailers (FT)	$121,390.00	$345.00	$0.39	$2.30	$2.86	$1.18	$3,260.00	$5.00	$0.29	$0.09	1
LGV, trucks less than 3.5 tons	$48,126.00	$158.63	$0.64	$3.47	$3.30	$2.01	$1,243.00	$6.20	$0.45	$0.14	1
Large bus	$100,364.00	$307.00	$0.64	$3.47	$3.30	$2.01	$3,333.00	$6.20	$0.45	$0.23	0
Medium bus	$100,364.00	$158.63	$0.64	$3.47	$3.30	$2.01	$3,333.00	$6.20	$0.45	$0.14	0

Table 17: Vehicle Fleet Characteristics

	Passenger Car Space Equivalent (PCSE)	No. of wheels	No. of axles	Kilometers driven per year (km)	Hours driven per year (hour)	Service Life (years)	%private use	No. of passengers	Work related passenger trips (%)	Operating Weight (tons)	ESAL factor
Utilization and Loading											
Very Heavy Goods Vehicles-Semi trailers (ST)	1.80	22.00	6.00	80000.00	1750.00	12.00	0.00	2.00	0.00	45.00	7.80
Motorcycles	0.50	2.00	2.00	6000.00	250.00	10.00	100.00	1.00	75.00	0.10	0.00
4 wheel drive	1.00	4.00	2.00	30000.00	750.00	10.00	0.00	3.80	35.00	2.30	0.01
Pickup 4x2	1.00	4.00	2.00	35000.00	750.00	10.00	0.00	5.50	40.00	2.20	0.01
HGV, trucks greater than 3.5Tons	1.60	10.00	3.00	75000.00	1750.00	12.00	0.00	2.00	50.00	13.80	4.20
Light bus	1.30	4.00	2.00	60000.00	1500.00	8.00	0.00	14.00	25.00	2.00	0.10
Medium Car	1.00	4.00	2.00	25000.00	450.00	8.00	100.00	4.00	35.00	1.30	0.00
MGV, trucks greater than 3.5Tons	1.40	6.00	2.00	40000.00	1000.00	12.00	0.00	2.00	50.00	8.00	2.60
Very Heavy Goods Vehicles-Full Trailers (FT)	1.80	22.00	6.00	120000.00	1670.00	16.00	0.00	0.00	0.00	45.00	2.28
LGV, trucks less than 3.5 tons	1.30	6.00	2.00	60000.00	1050.00	12.00	0.00	2.00	50.00	2.00	0.15
Large bus	1.60	10.00	3.00	120000.00	1500.00	15.00	0.00	49.00	75.00	16.70	17.70

	Passenger Car Space Equivalent (PCSE)	No. of wheels	No. of axles	Kilometers driven per year (km)	Hours driven per year (hour)	Service Life (years)	%private use	No. of passengers	Work related passenger trips (%)	Operating Weight (tons)	ESAL factor
Medium bus	1.60	6.00	2.00	80000.00	2000.00	10.00	0.00	40.00	25.00	6.00	2.60

IV. TRAFFIC CHARACTERISTICS AND GROWTH RATES

TRAFFIC CHARACTERISTICS

Traffic is a critical input to the HDM-4 modeling. Traffic data is calculated as classified Annual Average Daily Traffic (AADT) for a specified year (prior to intervention, in the case of an investment project) for the road sections in study. The base year (2010) traffic data prior to compact investment is available from the feasibility study report. Primary current traffic volume data collected for the evaluation is partly available at this stage from traffic volume surveys (i.e. Manual Traffic Counts) conducted by IMC. However, the traffic surveys may be conducted again during the data collection phase of the Base Period.[72] Traffic volume and traffic composition data available for year 2010 is presented in Table 18. This data will be used as base traffic for the "without-project" case. Traffic data obtained from surveys after project completion and data from traffic survey during the Base Period will be used to establish the traffic growth and traffic composition for the "with-project" case.

Table 18: Pre-compact AADTs on Project Roads

Section	From	To	2010 AADT
Segment 1[73]:	Nampula	Rio Ligonha	15,201
Segment 2[74]:	Namialo	Rio Lurio	2,227

TRAFFIC GROWTH

Estimates of annual traffic growth is an input within the Vehicle Fleet module. The feasibility report provides the traffic growth rates adopted for pre compact project assessment under 3 growth scenarios of low, median and high growth and using the estimated transport demand elasticity. Median growth rates were used in the economic analysis. The study of traffic counts conducted by IMC in 2019 for the Base Period will give an indication of realization of traffic growth since the pre-compact evaluation and project completion. The traffic growth rates to be adopted for the

[73] Nampula-Rio Ligonha Feasibility Study Executive Summary, Page 3, Table 2.2

[74] Namialo-Metoro Feasibility StudyExecutive Summary, page 8, table 4-1

remaining analysis period will be moderated based on this and vehicle growth trends in Mozambique. No generated traffic was considered in the pre-compact analysis prior to compact signing. The 2010 feasibility study consultants considered generated traffic. The MCC HDM model used for analysis during re-scoping adopted 2 to 5% generated traffic in case of Nampula Road and 10% in case of Namialo Road. General evidence shows that transport demand tends to expand at a somewhat faster rate than the economic growth rate as measured by national and regional GDPs[75]. This relationship is called transport demand elasticity and shall be derived by relating past GDP growth and traffic growth on the project road sections. Also, vehicle registration growth is an indicator of traffic growth and past data on vehicle registration growth will also be used to develop transport demand elasticity. Further transport demand elasticities used by other recent feasibility studies shall also be reviewed to finalize the transport demand elasticity to be adopted.

The traffic growth rates ascertained in the feasibility studies for the two roads predict that the Nampula-Rio Ligonha stretch will see a growth in generated traffic at 2%[76] of normal traffic per annum throughout the analysis period. The feasibility study also predicts that with the current GDP growth rate in Mozambique, it is unlikely that the traffic on the Nampula-Rio Ligonha road would increase beyond 4% per annum. The feasibility study for Namialo-Rio Lurio predicts a generated traffic growth of 30%[77] over the course of the analysis period, which seems to be very high for a Roads Rehabilitation project. The roads have been open since 2013 and enough time has passed for examining the traffic growth rate projected and realized. We will analyze the growth of traffic from base year to current year and any growth in excess of normal traffic growth assessed for the region will be considered as generated traffic

V. REGIONAL CLIMATE ZONE

The climate classification for Mozambique is tropical to sub-tropical. The annual rainfall varies between 800-1200 mm and rainfall distribution follows a north-south gradient with more rainfall along the coast. The Northern half of the country, where the rehabilitated roads along section N1 are located, receive approximately 1000 mm rainfall annually. The annual average temperature is 25-27 ºC [78] in the summer and 20-23 ºC in the winter. Since 1960, the proportion of days with heavy rainfall in the Northern part of Mozambique, have increased by 2.6% per decade, or an estimated 25 days per year.

As shown in Table 19 and Table 20, climate is defined by various temperature and moisture classifications in HDM-4, including temperature classifications of tropical, sub-tropical - hot, sub-tropical - cool, temperate - cool, and temperate - freeze; and moisture classifications of arid, semi-arid, sub-humid, humid, and perhumid. Each of these classifications have defined parameters with default values within HDM-4, including for parameters such as moisture index, duration of dry

[75] Fouquet, R. (2012) 'Trends in income and price elasticities of transport demand (1850-2010).' Energy Policy 50: 50-61

[76] Nampula-Rio Ligonha Feasibility Study Executive Summary,Page 4, Generated Traffic and Page 22, Section 7.6

[77] Namialo-Rio Lurio Feasibility Study Executive Summary, Page 9, section 4.4.2

[78]https://climateknowledgeportal.worldbank.org/country/Mozambique/climate-data-historical

season (months), mean monthly precipitation, mean temperature, average temperature range, days above 32 ºC, and percentage of time driven on snow or water covered roads.

Based on these classifications, the project region falls under the temperature classification of **Tropical**, and the moisture classification of **Subhumid.** The default parameter values of HDM-4 for this specific classification will be utilized in the HDM-4 modeling with modifications applied for which data is available. Based on the data for the period 1901-2016 from the World Bank climate change portal, average duration of dry season is 153 days (5 months), mean monthly precipitation is 82.65 mm, mean annual average temperature is 23.23 degrees.

Table 19: Temperature Classifications in HDM-4

Temperature Classification	Description	Typical Temperature Range (ºC)
Tropical	Warm temperatures in small range	20 to 35
Subtropical - hot	High day cool night temperatures; hot-cold seasons	-5 to 45
Subtropical - cool	Moderate day temperatures; cool winters	-10 to 30
Temperate - cool	Warm summer; shallow winter freeze	-20 to 25
Temperate - freeze	Cool summer, deep winter freeze	-40 to 20

Source: HDM-4 Volume 5. A Guide to Calibration and Adaptation. Chapter 7 - RDWE Calibration.

Table 20: Moisture Classifications in HDM-4

Moisture Classification	Description	Typical Moisture Index	Typical Annual Precipitation (mm)
Arid	Very low rainfall, high evaporation	-100 to -61	< 300
Semi-arid	Low rainfall	-60 to -21	300 to 800
Subhumid	Moderate rainfall, or strongly seasonal rainfall	-20 to 19	800 to 1600
Humid	Moderate warm season rainfall	20 to 100	1500 to 3000
Perhumid	High rainfall, or very many wet-surface days	> 100	> 2400

Source: HDM-4 Volume 5. A Guide to Calibration and Adaptation. Chapter 7 - RDWE Calibration.

VI. ROAD WORKS STANDARDS AND UNIT COSTS

HDM-4 compares a “without-project” situation with one or more “with-project” situations which enables the net economic impact of the proposed scheme(s) to be estimated.

The Road Works module of HDM-4 allows for Improvement and Maintenance standards for the “with-project” situation to be defined, together with their unit costs. For the evaluation of the Mozambique RRP, engineering and cost details of the improvement of the road section will need to be defined in this module. In addition, details of any recurrent maintenance work that should be considered in the economic evaluation will also need to be defined in this module so that a full picture of the capital and recurrent costs of the project design can be captured and compared against the benefits.

Similarly, for the “without-project” situation, any standard recurrent maintenance works on the road which would have occurred on the road regardless of the MCC road investment will need to be defined as well.

In defining the Improvement Standard (which correspond to the MCC roads investment), a number of parameters need to be defined. Data available from the as-built drawings already received are given. Some additional data need to be estimated from documents to be received including final costs etc.

IMPROVEMENT STANDARD

Details for defining improvement standard for the project road sections are given in Table 21. The data is given covering all values and for the pre-compact analysis 3 homogenous sections were considered for the analysis and the same number of homogenous sections will be considered in the evaluation. The HDM model data will be reviewed and updated from the as-built drawings during the analysis.

Table 21: Improvement Standard

Type	Parameter	Unit	Value
General	Existing Surface Class		Bituminous
	Improvement Type		Upgrading
	Duration	Years	2 years
	Intervention Type		Scheduled
Design	Speed Flow Type		Two-lane wide
	Road Class		Primary
	New Pavement Type		Double bituminous surface treatment (Asphalt concrete on 5.9 km in Rio Ligonha to Nampula Road)
	Length adjustment factor		1.0
	Increased in width	m	1.0 m for Namialo- Rio Lurio Road
	Additional no. of lanes		0.0
Intervention	Start year of intervention	calendar year	2012
Costs	Unit cost - economic	$/km	To be derived from analysis of final cost breakdown
	Unit cost - financial	$/km	To be derived from analysis of final cost breakdown
	Annual cost stream	%	To be derived from analysis of final cost breakdown
	Salvage value	%	To be derived from analysis of final cost breakdown using straight line depreciation method
Pavement	Surface material		Double bituminous surface treatment or Asphalt concrete
	Dry Season Structural No.		To be estimated from As-built drawings
	Surface Thickness	mm	25
	Relative Compaction	%	97
Geometry	Geometry class -		Mostly straight and undulating
	Rise + fall	m/km	Refer Table 12
	No. of rises + falls	no./km	Refer Table 12
	Average horizontal curvature	deg/km	Refer Table 12
	Super-elevation	%	Refer Table 12
	Acceleration noise	m/s^2	Refer Table 12
	Speed limit	kph	100
	Speed limit enforcement		1.0
	Speed reduction factors -		
	XNMT		1.0
	XMT		1.0

Type	Parameter	Unit	Value
	Roadside friction		1.0
Effects	After Works - Traffic Flow Pattern		To be derived based on traffic survey
	After Works - IRI	m/km	2.0 (to be reconfirmed)
	After Works - Mean Rut Depth	Mm	3 (to be reconfirmed)

MAINTENANCE STANDARD

The Maintenance Standards, both prevailing and most likely to be expected, in the "with-project" case, as well as the likely standard in the "without-project" case, are to be defined for the HDM-4 model to simulate the likely maintenance regime for the project road sections. The pre-compact analysis by SMEC and Scott Wilson, as well as the HDM model provided, indicate that two maintenance standards were adopted – one in which routine maintenance and overlay is considered and another where periodic maintenance is considered. The post compact analysis indicated concerns on the effective maintenance due to substantially lower increase in maintenance fund allocation for national road maintenance.

Overlay may be needed after 8 to 10 years of construction and is essential for sustainability of the rehabilitated pavement. This being a major maintenance cost, it will be important to see if timely periodic maintenance is happening on other roads that were rehabilitated prior to the MCC-funded roads. From KII with ANE and the Road Fund, it can be confirmed that routine maintenance is being taken up as needed on the MCC-funded roads. Defining the maintenance standard within the HDM-4 model is a critical component in simulating the road agency and road user costs, and not including the maintenance standard is equivalent to assuming no maintenance will be done. The assumption that no maintenance will be done will result in a very high IRI during the analysis period which is an unrealistic assumption and may distort the analysis. For the evaluation, the team will define the maintenance standard within the model based on the assessment of maintenance regime in operation in the country.

Each Maintenance Standard can consist of one or more work items that can be defined based on the roadway feature to which the maintenance standard will be applied. HDM-4 provides the following roadway features to select from: carriageway, miscellaneous, non-motorized traffic lane, shoulder, and special. Common maintenance operations that can then be selected to be applied to the selected roadway feature include: crack sealing, pothole patching, edge break repair, and periodic maintenance (overlay).

For each maintenance operation, the parameters that need definition differ. However, in general, they can be categorized into the following:

1. Design Parameters, including but not limited to
    - Surface material (for overlay or resurfacing)
    - Thickness of new surfacing, mm (for overlay and resurfacing)
    - Dry season strength coefficient (for overlay)
2. Intervention Parameters, including but not limited to
    - Time interval (years)
    - Last year for maintenance operation to be applied

- Maximum applicable roughness (IRI) above which the operation will not be performed
- Maximum quantity of material that should be used (for pothole patching)

3. Cost Parameters, including
    - Unit cost (economic and financial)
    - Unit costs of preparatory works (economic and financial)
4. Condition After Operation, including but not limited to
    - Roughness and rutting
    - Percentage of distress repaired

For the analysis, a realistic maintenance regime that is being practiced based on maintenance budget allocation trend will be adopted and defined in the model based on the findings of Evaluation Area 2.

VII. ECONOMIC ANALYSIS DATA

Discount Rate

A discount rate of 10% is proposed for this project as the standard rate used by MCC. The average interest rate in Mozambique is currently about 4.5%.[79]

Evaluation Period

The evaluation period will commence with project Compact start, in this case year 2012. The road improvement started in 2012 and was completed and opened for traffic in 2014. The final evaluation year would then be 2035, to cover 20 complete years from Compact completion. The evaluation will use constant prices, as is common practice in HDM-4 evaluations. The road user cost components to estimate project benefits are valued at 2019 prices and therefore road agency costs will also be updated to 2019 prices using inflation which averaged about 4% between 2012 and 2019.

Road Crash Costs

Road crash costs and benefits were not included in the pre-compact analysis. There is difficulty in obtaining reliable road crash rates for the project road prior to the investment. Significant increase in speed can actually increase road crash rates and therefore road crash statistics will be collected and analyzed to see if there is significant increase during the period for which data is available, including this in analysis may be considered.

[79] https://tradingeconomics.com/Mozambique/indicators

VIII. HDM DATA AND MODEL PARAMETERS FOR LEVEL I CALIBRATION

Sub-model	Description	Units	Discussed in Section	Value to be used		Remarks
				Before Project	With Project	
RUE	Aerodynamic drag coefficient			HDM4 Default		The default values given in HDM-4 shall be used unless more appropriate values are readily available.
	Aerodynamic drag coefficient multiplier			HDM4 Default		
	Average annual utilization	km/year	Section 3.2.2	Table 17		Data to be collected for vehicle categories for which data is not available and also reconfirm data in Table 17
	Average service life	years	Section 3.2.2	Table 17		Same as above
	Base number of retreads – NR0		Section 3.2.2	Data to be collected		
	Desired speed	m/s	Section 3.2.3	To be derived		Field observation during data collection
	Engine speed – a0			HDM4 Default		
	Engine speed – a1			HDM4 Default		
	Engine speed – a2			HDM4 Default		
	Engine speed – a3			HDM4 Default		
	Engine speed - Idle			HDM4 Default		
	Equivalent standard axles	ESA/veh	Section 3.2.2	Table 17		To be updated from axle load data from ANE
	Hours driven	h/yr	Section 3.2.2	Table 17		Data to be collected for vehicle categories for which data is not available and also reconfirm data in Table 17
	Number of axles		Section 3.2.2	Table 17		
	Number of wheels		Section 3.2.2	Table 17		
	Operating weight	t	Section 3.2.2	Table 17		
	Optimal life depreciation parameters			Constant life		
	Percentage of private use	%	Section 3.2.2	Table 17		To be updated from O-D survey
	Power - braking	kW		HDM4 Default		
	Power - driving	kW		HDM4 Default		

Sub-model	Description	Units	Discussed in Section	Value to be used		Remarks
				Before Project	With Project	
	Power - rated	kW		HDM4 Default		
	Projected frontal area	m2		HDM4 Default		
	Travel on wet roads	%	Section V	5		
	Travel on snow covered roads	%	Section V	20		
	Tire type		Section 3.2.2	Radial-ply		Pre-compact HDM-4 model
	Utilization method			Annual Kilometers driven		
	Volume of wearable rubber	dm3		HDM4 Default		
	Wheel diameter	m		HDM4 Default		
RDWE	Altitude	m	Section 2.2	Table 12		
	Area potholed	No. per km		2 to 20	N/A	Pre-compact HDM-4 model
	Area with **all** cracking	%		15	N/A	Same as above
	Area with **wide** cracking	%		70	N/A	Same as above
	Average rainfall	mm/month	Section V	42.9	42.9	
	Base type			Granular	Cement stabilized	Project feasibility study and As-built drawings
	Benkelman beam deflection	mm		N/A	From survey	Data to be collected
	Carriageway width	m		7.0	8.0	Project feasibility study and As-built drawings
	Construction age	yr		50	N/A	Project feasibility study report
	Effective number of lanes			2	2	Project feasibility study report
	Horizontal curvature	deg/km	Section 2.2 and 6.1	Table 12	Table 12	
	Mean rut depth	mm		5	From survey	Data to be collected
	Number of surface layers			2	2	Project feasibility study and As-built drawings
	Posted speed limit	Km per hour		N/A	80	Data to be verified
	Preventative treatment age	yr		NA	N/A	
	Rise plus fall	m/m	Section 2.2	Table 12		
	Roughness	IRI	Section 2.2	9.0 to 10.0	From survey	Data to be collected

Sub-model	Description	Units	Discussed in Section	Value to be used		Remarks
				Before Project	With Project	
	Roughness age term		HDM Manual	2.28	1.52	
	Roughness progression			1.0	1.0	Pre-compact HDM-4 model. Will verify the model prediction to field observations
	Sand patch texture depth	mm		N/A	N/A	
	Shoulder width	m	Section 2.2	2.5	2.0	Project feasibility study and As-built drawings
	Structural number			0.95	To be estimated	Pre-compact HDM-4 model
	Subgrade CBR	%		8	8	Project feasibility study report
	Super elevation	%		5	5	
	Surface type			Table 12		
	Surfacing age	yr		Table 12		
	Unit costs for construction and maintenance			To be estimated		From construction and maintenance costs
	Crack initiation factor		HDM Manual	1.0		Pre-compact HDM-4 model. Will verify the model prediction to field observations
	Crack progression factor		HDM Manual	1.0		
	Pothole progression		HDM Manual	1.0	1.0	
	Raveling initiation		HDM Manual	0.0	0.0	
	Raveling progression		HDM Manual	0.0	0.0	
	Raveling retardation factor	%	Appendix D	HDM 4 default	HDM 4 default	
	Rut depth progression		HDM Manual	1.0	1.0	
TRAFFIC	Average annual daily traffic	veh/day	Section 4.1	Table 18	From survey	Data to be collected
	Traffic growth rate	%/year	Section 4.2	Table 19	To be estimated	Data to be collected

Sub-model	Description	Units	Discussed in Section	Value to be used		Remarks
				Before Project	With Project	
	Hourly distribution of traffic		Section 4.2	Values from pre-compact HDM model	From survey	Data to be collected.
UNIT COSTS	Cost of cargo	cost/Ton/h	Section 3.2.2	Table 17		Update based on vehicle operating cost data collection
	Cost of crew	cost/h				
	Cost of fuel	cost/l				
	Cost of maintenance labor	cost/h				
	Cost of oil	cost/l				
	Cost of overhead	cost/yr				
	Cost of retreaded tire	%	Section 3.2.2	From survey	From survey	Data to be collected.
	Cost of travel time	cost/h		Table 17		Update based on vehicle operating cost data collection
	Cost of tire	cost/tire				
	Cost of vehicle	cost/vehicle				
	Interest rate	%				
ECONOMIC	Discount rate	%	Section 7	10	10	
	Analysis period	yr	Section 7	2+20 (2012-2035)		

IX. FATIGUE CURVE

The remaining service life of pavement can be estimated using AASHTO 1993, "AASHTO Guide for Design of Pavement Structures" method. It is one of the well-known methods on service life calculations and based on the Structural Number. In Part III, Pavement Design Procedures for Rehabilitation of Existing Pavements in the AASHTO procedure, remaining life is calculated based on total traffic to date (ESALs) and total traffic to pavement failure, which can be calculated (estimated) using the same new pavement design equations/ charts (please refer to Part III AASHTO Guide for Design of Pavement Structures, pages III-88 to III-105).

As a part of remaining service life calculation, remaining fatigue life needs to be calculated. Based on mechanistic equation and also Asphalt institute model, to estimate the remaining fatigue life, allowable number of loadings until fatigue cracking happens needs to be calculated. One of the best-known equations to calculate the number of fatigue life is equation (1) which relates the fatigue life of asphalt concrete to the horizontal strain at the bottom of asphalt layer and the modulus of elasticity of asphalt layer. Modulus of elasticity can be evaluated and measured by running mechanical test on the cored sample from the pavement or fabricated sample at the lab with the exact same material as the one pavement constructed with or it can be estimated based on semi empirical-mechanistic equations, measuring, E, the modulus of elasticity, by test would be preferred since the estimation of the modulus of elasticity by equations will lead to some levels of uncertainty.

Tensile horizontal strain of asphalt concrete layer at the bottom of the layer can be modelled and calculated. For this purpose and to model the pavement, elastic layer modeling software such as Kenlayer (Kenpave) can be used. Figure 7 shows a typical cross section of layered pavement system which will be modeled. In such a models Subgrade is considered as a semi-infinite layer which other layers have specific height with known elastic behavior properties (E, Poisson's ratios). By applying the load on the surface of the layered pavement with known properties of layers, horizontal tensile strain at the bottom of the asphalt layer can be calculated and then by knowing the strain and the Elastic modulus of the layer, allowable number of load repetitions to prevent fatigue cracking, N_f, can be determined based on Asphalt Institute equation.

$$N_f = f_1(\varepsilon_t)^{-f_2}(E_1)^{-f_3} \qquad (1)$$

where:

N_f, is the allowable number of fatigue load repetitions,

f_1, f_2, f_3 are constants determined from laboratory fatigue tests, f_1 modified to correlate with field performance observations. The Asphalt Institute suggested 0.0796, 3.291, and 0.84 for f_1, f_2,f_3, respectively.

ε_t, is the horizontal, tensile strain at the bottom of asphalt layer,

E_1, is the modulus of elasticity of asphalt layer, which will be obtained from modulus tests of cores, cross-referenced with the modulus calculated from deflection measurements and the as-built drawings.

In the proposed method, horizontal strain at the bottom of the Asphalt Mix Layer will be calculated based on the layered theory models. In the model user will input physical (mechanical) layer properties such as Young's Elastic Modulus, layer depth, Poisson's ratio. And the horizontal strain will be calculated for each combination. CTB layers would be stiffer than granular base layers and their Young's Modulus would be higher.

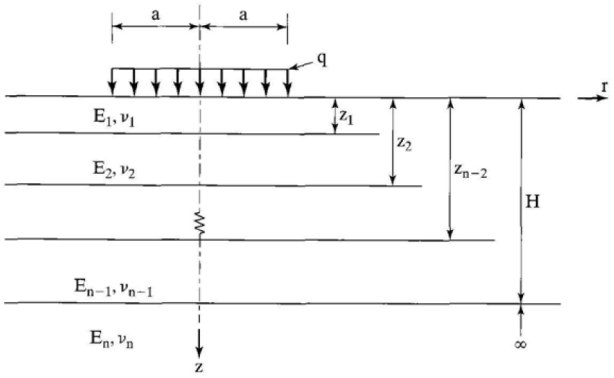


Figure 7. A typical cross section of layered pavement system

To estimate the percentage of surface cracked during service life of the pavement, one of the transfer functions from the MEPDG can be implemented as below:

$$FC = \left(\frac{6000}{1 + e^{C_1 - C_2 * \log D}}\right) * \left(\frac{1}{60}\right)$$

where:

FC, is the percentage of fatigue cracking of total lane area

D, is the damage ratio number of applied loads over number of allowable loads

C_1, is $-2 * C_2$

C_2, is $-2.40874 - 39.748 * (1 + h_{ac})^{-2.85609}$, and

h_{ac}, is the asphalt layer thickness (inches)

Based on the above approach, by knowing the layer properties and traffic loads, percentage of cracked area can be estimated and plotted versus service time for a specific section of the road. Using this model, *FC*, the percentage of fatigue cracking of total lane area will be calculated/estimated by the model and on the other hand site measurements will provide us with the actual percentage of cracking area.

By applying the measurement at year 5 to the mechanistic (proposed) model, FC, for the future years can be estimated. By extracting some points from the mechanistic model, the K_{cia}, calibration parameter of the HDM-4 built-in model for the AMSB can be defined and input to the system.

ANNEX VII: PROPOSED DEVIATIONS FROM ANNEX J.9

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
Evaluation Question 0				
Output: MCC Road Reconstruction and Rehabilitation	List of deviations from original Compact design	No requirement specified	**Secondary Sources** • Review MCC Project Documents • ANE documents • Road Fund documents **Key Informant Interviews** • 3 Semi-structured interviews with ANE, the Road Fund and other stakeholders who are familiar with the compact • Sample unit: Stakeholder groups to be interviewed are MCC, ANE staff, Road Fund staff and former MCA-M staff • Target respondents: Representatives of stakeholder groups	• N/A
Evaluation Question 1				
Outcome: Reduced transportation costs (travel time and VOCs) & **Outcome**: Reduced maintenance costs	Average Annual Daily Traffic of the MCC-funded road sections (*R-10 MCC Common Indicator list*)	**Manual Traffic Count survey** • Methodology: US FHA Traffic Monitoring Guide • Location: well outside urban areas • Adjustment: seasonal traffic variation • Presentation: graphic representation of traffic counting stations, traffic volume on aerial imagery and itinerary diagrams	**Manual Traffic Count survey** IDG will use IMC traffic count data and conduct a partial new survey based on field assessment.	There are no deviations from Annex J.9 requirements.

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
	Vehicle occupancy – to be ascertained via Average Annual Daily Traffic (*R-10 MCC Common Indicator list*) Trip purpose (business, leisure or other) (*R-19 & R20 MCC Common Indicator list*) Travel time (*R-17 MCC Common Indicator list*) Cargo value (*R-22 MCC Common Indicator list*)	**Origin-Destination survey** ○Location: well outside urban areas ○Survey period: 6am – 8pm ○Survey days: 2 consecutive market/non-market days ○Sample rate: 20% of each vehicle type at each site ○Presentation: graphic representation of O-D stations on aerial imagery and itinerary diagrams	**Origin-Destination survey** ○Locations: • Traffic Count Station 2 at km 5 (north of Namialo) • Traffic Count Station 5 at km 142.0 (north of Namialo) • Traffic Count Station 1 at km 97.7 (just south of Nampula) or Traffic Count Station 2 at km 66.3 (30 km south of Nampula) • Traffic Count Station 4 at km 0.0 (at Rio Ligonha) ○ Survey Days: 3 days 24 hours	There are no deviations from Annex J.9 requirements.
	Equivalent standard axle loads (ESAL) factor	**Axle Load Survey** • Methodology: distinguish domestic/int'l traffic • Survey period: 6am – 8pm • Survey days: one week • Adjustment: present both 8.2 ton and 13-ton equivalent factor by vehicle class • Presentation: axle weight and heavy weight volume displayed in a tabular format and stations integrated on aerial imagery and itinerary diagram	**Axle Load Survey** • Use existing sources from the 2015 survey for the feasibility study	We recommend using secondary data from the previous 2015 survey, because historical secondary data will reveal the context of the situation up to present day, whereas a primary survey will only provide a snapshot.

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
	Cost of Transportation (*R-23 MCC Common Indicator list*)	**Vehicle Operating Costs** • Methodology: in accordance with HDM-4 Volume 5 • Sample: major transport operators, garages, vehicle concessionaires and on a sample of private road users from the O-D work • Data: # of wheels, axles, length of vehicle (m), tire type and price, operating weight (kg), annual km driven, annual working hours, average service life, vehicle price (new), fuel type and price, lubricant price, maintenance labor cost, annual overhead cost, annual bank interest	**Vehicle Operating Cost survey** Latest VOC data available with ANE was calibrated in 2016. This data updated to the analysis year by ANE will be used.	There are no deviations from Annex J.9 requirements.
	Kilometers of road network with evidence-based maintenance execution (*R-28.1 MCC Common Indicator list*)	No requirement specified		N/A
	Road physical parameters for HDM-4	No requirement specified		N/A
	International Roughness Index (IRI) (*R-9 MCC Common Indicator list*)	**Road Roughness Survey** • Equipment: Class 3 or better device per ASTM or WB Technical Paper 46 • Methodology: outer wheel path of each lane • Interval: 100-meter intervals • Presentation: sub-section the road segments into	This evaluation will use a Class 1 measuring device (laser profiler).	No deviation from Annex J.9 requirements

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
		homogenous or dynamic sections		
	Road condition parameters for HDM-4	**Road Condition study** • Standard: LTPP Distress Identification Manual • Data: maintenance performed; deterioration causes • Analysis: in accordance with HDM-4 requirements • Presentation: graphical presentation using color categories on aerial imagery	No detailed road condition study is anticipated. The road condition will be estimated based on visual assessment of the major surface distresses that will be performed during Road Roughness survey. The Roads/Pavement Engineer will also inspect the maintenances performed, potential cause of deterioration, and the location alongside the road.	The visual assessment will be sufficient for the purposes of this evaluation.
	AC pavement: Structural Number (SN)	**Deflection** • Standard: ASTM • Methodology: outer wheel path • Timing: during or at the end of the rainy season • Interval: 1-kilometer increments • Analysis: obtain modulus of every pavement layer and subgrade; obtain pavement layer and determine remaining structural life • Adjustment: determine both rainy and dry season deflection Presentation: subsection the road segments into homogenous or dynamic sections	The evaluation will use data from previous surveys completed in 2015 and as-built drawings	The existing data is sufficient for the purposes of this evaluation.
	AC pavement: Layer thickness and coefficients	**Geotechnical study** • Equipment: Ground Penetrating Radar (GPR)	The evaluation will use data from previous surveys completed in 2015 and as-built drawings	The existing data is sufficient for the purposes of this evaluation.

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
		• Analysis: determine the subgrade modulus and California Bearing Ratio (CBR); modulus of every layer; adjusted structural number Presentation: sub-section the road segments into homogenous or dynamic sections		
	California Bearing Ratio (CBR)	**Geotechnical study** • Equipment: Ground Penetrating Radar (GPR) • Analysis: determine the subgrade modulus and California Bearing Ratio (CBR); modulus of every layer; adjusted structural number Presentation: sub-section the road segments into homogenous or dynamic sections	The evaluation will use data from previous surveys completed in 2015 and as-built drawings	The existing data is sufficient for the purposes of this evaluation.
	Satellite imagery	Recent satellite imagery for pre-construction work: • Resolution of 50cm or better Aerial imagery • Resolution of 5cm or better All images purchased must have all metadata and end user rights attached showing MCC as the end user. This data shall be fully integrated into the relational GIS database.	IDG will include satellite imagery as required.	No deviation from Annex J.9 requirements
Evaluation Question 2A				

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
Assumption:	Requested annual maintenance budget (*R-29.2 MCC Common Indicator list*)	• The Evaluator will assess the adequacy of planning, financing and implementation mechanisms to sustain the quality of road conditions over the long term • The Evaluator shall assess the quality of the collected road data on the relevant section and compare to the Evaluators data to determine accuracy	**Secondary Sources** Review available secondary sources from ANE	No deviation from Annex J.9 requirements
	Annual road maintenance funds allocated (*R-29.1 MCC Common Indicator list*)		**Secondary Sources** Review available secondary sources from ANE	
	Annual road maintenance budget spent (*R-30.1 MCC Common Indicator list*)		**Secondary Sources** Review available secondary sources from ANE	
	Proportion of kilometers of road network with evidence-based maintenance execution		**Secondary Sources** Review available secondary sources from ANE	
	International Roughness Index (*R-9 MCC Common Indicator list*)	**Road Roughness Survey** • Equipment: Class 3 or better device per ASTM or WB Technical Paper 46 • Methodology: outer wheel path of each lane • Interval: 100-meter intervals • Presentation: sub-section the road segments into homogenous or dynamic sections	This evaluation will use a Class 1 measuring device (laser profiler).	No deviation from Annex J.9 requirements
	Road Conditions Study (percentage of pavement surface cracked)	**Road Condition study** • Standard: LTPP Distress Identification Manual	No detailed road condition study is anticipated. The road condition will be estimated based on visual assessment of the major surface	No deviation from Annex J.9 requirements

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
		• Data: maintenance performed; deterioration causes • Analysis: in accordance with HDM-4 requirements • Presentation: graphical presentation using color categories on aerial imagery **Road Condition study** • Standard: LTPP Distress Identification Manual • Data: maintenance performed; deterioration causes • Analysis: in accordance with HDM-4 requirements • Presentation: graphical presentation using color categories on aerial imagery	distresses that will be performed during Road Roughness survey. The Roads/Pavement Engineer will also inspect the maintenances performed, potential cause of deterioration, and the location alongside the road. No detailed road condition study is anticipated. The road condition will be estimated based on visual assessment of the major surface distresses that will be performed during Road Roughness survey. The Roads/Pavement Engineer will also inspect the maintenances performed, potential cause of deterioration, and the location alongside the road.	
Evaluation Question 2B				
Assumption:	Requested annual maintenance budget (*R-29.2 MCC Common Indicator list*) Annual road maintenance funds allocated (*R-29.1 MCC Common Indicator list*) Annual road maintenance budget spent (*R-30.1 MCC Common Indicator list*)	• The Evaluator will assess the adequacy of planning, financing and implementation mechanisms to sustain the quality of road conditions over the long term • The Evaluator shall assess the quality of the collected road data on the relevant section and compare to the Evaluators data to determine accuracy • Collect the condition assessments of the network over the past ten years	**Secondary Sources** • Review available secondary sources from ANE and the Road Fund **Road Condition study and Road Roughness study** • Use data collection under Evaluation Question 1	No deviation from Annex J.9 requirements
Evaluation Question 2C				

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
	Annual road maintenance funds allocated (*R-29.1 MCC Common Indicator list*)	• Sector-level analysis (as well as project-level analysis) should dive more deeply into why the status quo is what it is and why it persists. • The Evaluator should develop a series of questions and appropriate data collection and analysis methodologies to address those questions, in coordination with MCC.	Review available secondary sources from ANE and the Road Fund	No deviation from Annex J.9 requirements
	Annual road maintenance budget spent (*R-30.1 MCC Common Indicator list*)		Review available secondary sources from ANE and the Road Fund	
	Quality of maintenance performed on MCC-funded road		Review available secondary sources from ANE and the Road Fund	
	International Roughness Index (*R-9 MCC Common Indicator list*)	**Road Roughness Survey** • Equipment: Class 3 or better device per ASTM or WB Technical Paper 46 • Methodology: outer wheel path of each lane • Interval: 100-meter intervals Presentation: sub-section the road segments into homogenous or dynamic sections	This evaluation will use a Class 1 measuring device (laser profiler).	No deviation from Annex J.9 requirements
	Road Conditions Study (percentage of pavement surface cracked)	**Road Condition study** • Standard: LTPP Distress Identification Manual • Data: maintenance performed; deterioration causes • Analysis: in accordance with HDM-4 requirements • Presentation: graphical presentation using color categories on aerial imagery	No detailed road condition study is anticipated. The road condition will be estimated based on visual assessment of the major surface distresses that will be performed during Road Roughness survey. The Roads/Pavement Engineer will also inspect the maintenances performed, potential cause of deterioration, and the location alongside the road.	No deviation from Annex J.9 requirements

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
		Road Condition study • Standard: LTPP Distress Identification Manual • Data: maintenance performed; deterioration causes • Analysis: in accordance with HDM-4 requirements Presentation: graphical presentation using color categories on aerial imagery		
Evaluation Questions 3A and 3B				
Outcome:	Average Annual Daily Traffic (to number and type of vehicle) (*R-10 MCC Common Indicator list*)	**Origin-Destination Survey** • See description under Evaluation Question 1	**Origin-Destination survey** • See description under Evaluation Question 1 **Public Transport User Survey** • Survey of public transport users • Survey period: same as the O-D • Sample unit: Individual public transport users (over the age of 18) on board the buses traveling along the MCC-supported road, and/or waiting at bus stations to board. • Target respondents: Individual public transport users	The PTU survey is proposed to allow the interviewers sufficient time to ask in-depth questions on the journey and any changes before and after the road improvement.
	Trip Purpose (Business, Leisure and other) (*R-19 and R-20 MCC Common Indicator list*)			
	Transport fares (*R-25 MCC Common Indicator list*)			
	Cargo Value and Cargo Weight (*R-21 and R-22 MCC Common Indicator list*)			
	Travel Time (*R-17 MCC Common Indicator list*)		**Travel Time Study** • A test vehicle will be dispatched to travel along the project corridor	

Program Logic Result	Indicator	Annex J.9 Requirements	Post-Compact Proposed New Data Source	Rationale for Deviation from Annex J.9Requirements
			during peak and lean traffic periods • Travel times will be recorded at designated intervals and checkpoints • Instrument: paper forms • Survey period: July 2022	
Evaluation Question 4				
Outcome: **Assumption**:	Cost of Transportation (*R-23 MCC Common Indicator list*)	The Evaluator shall review the country's regulatory structure, formal institutions that impact the sector, and informal institutions that may influence pricing. The primary goal is to understand the market imperfections, and how those imperfections may limit the amount of cost savings that are passed on to users of transport services.	**Key Informant Interviews** • Key Informant Interviews (semi-structured) with public transportation service providers (of short and long-distance bus routes on N1) and transport service regulators to understand the transport policies and their impacts **Origin-Destination survey** • See description under Evaluation Question 1 **PTU** • See description under Evaluation Question 3A **Secondary Sources** • Review historical records of transportation prices	The PTU survey is proposed to allow the interviewers sufficient time to ask in-depth questions on the journey and any changes before and after the road improvement. No other deviation from Annex J.9 requirements.
	Transportation market laws, policies, and processes	The Evaluator shall review the country's regulatory structure, formal institutions that impact the sector, and informal institutions that may influence pricing. The primary goal is to understand the market imperfections, and how those imperfections may limit the amount of cost savings that are passed on to users of transport services.	**Key Informant Interviews** •Key Informant Interviews (semi-structured) with public transportation service providers (of short and long-distance bus routes on N1) and transport service regulators (ANE, municipalities) to understand the transport policies and their impacts **Secondary Sources** •Review of Transportation market regulations, policies, and processes	

ANNEX VIII: EVALUABILITY ASSESSMENT REPORT

The Evaluability Assessment Report was excluded from the external version of the Evaluation Design Report.